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(BAW—10074A(Rev.1))
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SCHROEDINGER EQUATION
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CONTENTS

Category	Page
COAL AND COAL PRODUCTS	2631
PROCESSING	2631
CARBONIZATION	2631
DESULFURIZATION AND PURIFICATION	2631
HYDROGENATION	2631
GASIFICATION	2631
LIQUEFACTION	2635
PYROLYSIS AND CRACKING	2637
SOLVENT EXTRACTION	2637
BY-PRODUCTS	2637
PROPERTIES	2638
WASTE MANAGEMENT	2638
ENVIRONMENTAL ASPECTS	2639
RESERVES AND EXPLORATION	2640
MINING	2640
TRANSPORT AND HANDLING	2642
COMBUSTION	2642
MARKETING AND ECONOMICS	2643
HEALTH AND SAFETY	2644
PETROLEUM	2644
RESERVES	2644
GEOLOGY AND EXPLORATION	2644
DRILLING AND PRODUCTION	2647
PROCESSING	2648
PRODUCTS AND BY-PRODUCTS	2650
HEALTH AND SAFETY	2652
MARKETING AND ECONOMICS	2652
WASTE MANAGEMENT	2652
ENVIRONMENTAL ASPECTS	2652
POLICY, LEGISLATION, AND REGULATION	2653
TRANSPORT, PIPELINES, AND HANDLING	2653
PROPERTIES	2653
STORAGE	2654
COMBUSTION	2655
NATURAL GAS	2655
RESERVES	2655
GEOLOGY AND EXPLORATION	2655
DRILLING, PRODUCTION, AND PROCESSING	2655
PRODUCTS AND BY-PRODUCTS	2656
HEALTH AND SAFETY	2657
MARKETING AND ECONOMICS	2657
WASTE MANAGEMENT	2659
ENVIRONMENTAL EFFECTS	2659
ARTIFICIAL STIMULATION, PLOWSHARE, ETC.	2659
POLICY, LEGISLATION, AND REGULATION	2660
TRANSPORT, PIPELINES, AND HANDLING	2660
PROPERTIES	2662
COMBUSTION	2662
STORAGE	2662
OIL SHALES AND TAR SANDS	2663
SITE GEOLOGY AND HYDROLOGY	2663
SITE GEOLOGY	2663
DRILLING, FRACTURING, AND MINING	2663
OIL PRODUCTION, RECOVERY, AND REFINING	2663
IN SITU METHODS, TRUE AND MODIFIED	2664
REFINING	2664
PROPERTIES AND COMPOSITION	2664
DIRECT USES AND BY-PRODUCTS	2664
ENVIROMENTAL ASPECTS	2664
NUCLEAR FUELS	2664
RESERVES	2664
EXPLORATION	2665
MINING	2666
FEED PROCESSING	2666

Category	Page
ENRICHMENT	2666
GASEOUS DIFFUSION	2666
LASER EXCITATION	2666
FUELS PRODUCTION AND PROPERTIES	2666
SPENT FUELS REPROCESSING	2667
TRANSPORT AND STORAGE	2667
MARKETING AND ECONOMICS	2667
WASTE MANAGEMENT	2667
WASTE PROCESSING	2667
WASTE DISPOSAL AND STORAGE	2668
ENVIRONMENTAL ASPECTS	2669
HEALTH AND SAFETY	2670
REGULATIONS	2670
ACCOUNTABILITY AND SAFEGUARDS	2670
SOURCES	2670
ISOTOPE AND RADIATION SOURCE TECHNOLOGY	2670
DESIGN AND FABRICATION	2670
ISOTOPIC POWER SUPPLIES	2670
DESIGN AND FABRICATION	2670
HYDROGEN	2670
PRODUCTION	2670
THERMOCHEMICAL PROCESSES	2671
STEAM-IRON PROCESS	2671
STORAGE	2671
TRANSPORT	2671
INDUSTRIAL AND COMMERCIAL USE	2671
OTHER SYNTHETIC AND NATURAL FUELS	2671
PREPARATION	2671
PREPARATION FROM WASTES OR BIOMASS	2671
ALCOHOL FUELS	2672
PREPARATION	2672
CHEMICAL SYNTHESIS	2672
PREPARATION FROM WASTES OR BIOMASS	2672
PROPERTIES	2672
PREPARATION	2672
SOLID WASTE FUELS	2672
HYDRO ENERGY	2673
RESOURCES AND AVAILABILITY	2673
PLANT DESIGN AND OPERATION	2673
POWER CONVERSION SYSTEMS	2673
SOLAR ENERGY	2673
RESOURCES AND AVAILABILITY	2674
ECONOMICS	2674
ENVIRONMENTAL, LEGAL, AND INSTITUTIONAL ASPECTS	2674
SOLAR ENERGY CONVERSION	2674
PHOTOVOLTAIC CONVERSION	2674
BIOMASS PRODUCTION AND CONVERSION	2676
PHOTOCHEMICAL AND THERMOCHEMICAL CONVERSION	2678
PHOTOVOLTAIC POWER PLANTS	2678
SOLAR THERMAL POWER PLANTS	2679
CENTRAL RECEIVER	2679
DISTRIBUTED COLLECTOR	2678
TOTAL ENERGY AND HYBRID SYSTEMS	2680
OCEAN THERMAL GRADIENT POWER PLANTS	2680
SOLAR RADIATION UTILIZATION	2680
SPACE HEATING AND COOLING	2680
AGRICULTURAL AND INDUSTRIAL PROCESS HEAT	2681
WATER HEATING	2681
OTHER	2682
SOLAR COLLECTORS AND CONCENTRATORS	2682

Category	Page
HEAT STORAGE	2684
GEOTHERMAL ENERGY	2685
RESOURCE STATUS AND ASSESSMENT	2685
GEOLOGY, HYDROLOGY, AND GEOTHERMAL SYSTEMS	2685
USA	2685
NON-USA	2685
GEOTHERMAL EXPLORATION AND EXPLORATION TECHNOLOGY	2686
GEOPHYSICAL TECHNIQUES AND SURVEYS	2686
GEOCHEMICAL TECHNIQUES AND SURVEYS	2687
EXPLORATORY DRILLING AND WELL LOGGING	2687
GEOTHERMAL ENGINEERING	2687
DRILLING TECHNOLOGY AND WELL HARDWARE	2687
RESERVOIR STIMULATION AND EXTRACTION TECHNOLOGY	2687
GEOTHERMAL DATA AND THEORY	2687
PROPERTIES OF AQUEOUS SOLUTIONS	2688
PROPERTIES OF MINERALS AND ROCKS	2688
ROCK-WATER-GAS INTERACTIONS	2688
TIDAL POWER	2689
WIND ENERGY	2689
AVAILABILITY (CLIMATOLOGY)	2689
ECONOMICS	2689
WIND ENERGY ENGINEERING	2689
TURBINE DESIGN AND OPERATION	2689
ELECTRIC POWER ENGINEERING	2689
POWER PLANTS AND POWER GENERATION	2689
COOLING AND HEAT TRANSFER EQUIPMENT AND SYSTEMS	2689
POWER CYCLES	2690
COMPONENTS	2691
WASTE HEAT UTILIZATION	2694
ECONOMICS	2694
FUELS	2695
ENVIRONMENTAL ASPECTS	2695
NOXIOUS GAS AND PARTICULATE ABATEMENT AND CONTROL	2695
POWER TRANSMISSION AND DISTRIBUTION	2695
AC SYSTEMS, EHV AND UHV	2695
NUCLEAR POWER PLANTS	2696
POWER REACTORS, NON-BREEDING, LIGHT-WATER MODERATED, BOILING WATER COOLED	2696
POWER REACTORS, NON-BREEDING, LIGHT-WATER MODERATED, NON-BOILING WATER COOLED	2698
POWER REACTORS, NON-BREEDING, GRAPHITE MODERATED	2700
POWER REACTORS, NON-BREEDING, OTHERWISE MODERATED OR UNMODERATED	2701
POWER REACTORS, BREEDING	2701
POWER REACTORS, AUXILIARY, MOBILE, PACKAGE, AND TRANSPORTABLE	2706
REGULATION AND LICENSING	2706
ECONOMICS	2706
CONSTRUCTION AND OPERATION	2707
FUEL CYCLE	2707
PROCESS HEAT REACTORS	2707
NUCLEAR REACTOR TECHNOLOGY	2707
THEORY AND CALCULATION	2707
COMPONENTS AND ACCESSORIES	2708
FUEL ELEMENTS	2711
CONTROL SYSTEMS	2712
ENVIRONMENTAL ASPECTS	2713
SITING	2714
RADIOACTIVE EFFLUENTS	2714
CHEMICAL AND THERMAL EFFLUENTS	2714
RESEARCH, TEST, AND EXPERIMENTAL REACTORS	2714
PROPULSION REACTORS	2715
REACTOR SAFETY	2715
ENERGY STORAGE	2719
MAGNETIC	2719
PUMPED HYDRO	2719
THERMAL	2719
BATTERIES	2720
DESIGN AND DEVELOPMENT	2720
PERFORMANCE AND TESTING	2720
MATERIALS, COMPONENTS, AND AUXILIARIES	2720
APPLICATIONS	2721
ENERGY MANAGEMENT AND POLICY	2721
ENERGY ANALYSIS AND MODELING	2721
ECONOMICS AND SOCIOLOGY	2721
ENVIRONMENT, HEALTH, AND SAFETY	2722
ENERGY RESOURCES	2722
RESEARCH AND DEVELOPMENT	2722
NUCLEAR ENERGY	2722
TRANSPORT AND STORAGE	2722
WASTE HEAT UTILIZATION	2722
CONSERVATION	2723
SUPPLY, DEMAND, AND FORECASTING	2723
POLICY, LEGISLATION, AND REGULATION	2723
FOSSIL FUELS	2724
COAL	2724
PETROLEUM	2724
NATURAL GAS	2724
HYDROGEN AND SYNTHETIC FUELS	2724
ELECTRIC POWER	2725
ELECTRIC POWER GENERATION	2725
CONSUMPTION AND UTILIZATION	2725
UNCONVENTIONAL SOURCES AND POWER GENERATION	2725
SOLAR	2725
OTHER	2725
ENERGY CONVERSION	2726
MHD GENERATORS	2726
DESIGN AND DEVELOPMENT	2726
PERFORMANCE AND TESTING	2726
MATERIALS, COMPONENTS, AND AUXILIARIES	2726
DUCT ENGINEERING AND FLUID DYNAMICS	2726
EHD GENERATORS	2727
DESIGN AND DEVELOPMENT	2727
THERMIONIC CONVERTERS	2727
PERFORMANCE AND TESTING	2727
FUEL CELLS	2727
DESIGN AND DEVELOPMENT	2727
MATERIALS, COMPONENTS, AND AUXILIARIES	2727
ENERGY CONSERVATION, CONSUMPTION, AND UTILIZATION	2727
BUILDINGS	2727
RESIDENTIAL BUILDINGS	2728
OFFICE BUILDINGS	2728
SCHOOL, MUNICIPAL AND OTHER PUBLIC BUILDINGS	2728
COMMERCIAL AND INDUSTRIAL BUILDINGS	2728
TRANSPORTATION	2728
LAND AND ROADWAY	2728
INDUSTRY AND AGRICULTURE	2729
ENERGY SOURCES	2729
EQUIPMENT AND PROCESSES	2729
WASTE HEAT RECOVERY AND UTILIZATION	2730
INDUSTRIAL WASTE MANAGEMENT	2730
MUNICIPALITIES AND COMMUNITY SYSTEMS	2730
MUNICIPAL WASTE MANAGEMENT	2730

Category	Page
ADVANCED AUTOMOTIVE PROPULSION SYSTEMS	2731
SPARK-IGNITION	2731
EXTERNAL COMBUSTION ENGINES	2731
STIRLING CYCLE	2731
ELECTRIC-POWERED SYSTEMS	2731
HYBRID SYSTEMS	2731
FLYWHEEL PROPULSION	2731
VEHICLE DESIGN FACTORS	2731
BODY AND CHASSIS	2731
ENGINE-TRANSMISSION MATCHING	2732
ENGINE SYSTEM	2732
ALTERNATIVE FUELS	2732
MATERIALS	2732
METALS AND ALLOYS	2733
PREPARATION AND FABRICATION	2733
MECHANICAL PROPERTIES	2733
PHYSICAL PROPERTIES	2733
CORROSION AND EROSION	2736
RADIATION EFFECTS	2736
CERAMICS, CERMETS, AND REFRACTORIES	2736
PREPARATION AND FABRICATION	2736
STRUCTURE AND PHASE STUDIES	2736
MECHANICAL PROPERTIES	2736
PHYSICAL PROPERTIES	2737
RADIATION EFFECTS	2737
COMPOSITE MATERIALS	2737
PHYSICAL PROPERTIES	2737
DEGRADATION AND EROSION	2738
OTHER MATERIALS	2738
PREPARATION AND MANUFACTURE	2738
STRUCTURE AND PHASE STUDIES	2738
PROPERTIES	2738
CORROSION, EROSION, AND DEGRADATION	2739
RADIATION EFFECTS	2739
CHEMISTRY	2740
ANALYTICAL AND SEPARATIONS CHEMISTRY	2740
ACTIVATION AND NUCLEAR REACTION PROCEDURES	2740
CHEMICAL PROCEDURES	2740
RADIOMETRIC AND RADIOCHEMICAL PROCEDURES	2740
SPECTRAL PROCEDURES	2740
SEPARATION PROCEDURES	2740
INORGANIC AND PHYSICAL CHEMISTRY	2740
CHEMICAL AND PHYSICOCHEMICAL PROPERTIES	2740
ORGANIC CHEMISTRY	2742
CHEMICAL AND PHYSICOCHEMICAL PROPERTIES	2742
ISOTOPE EFFECTS	2742
ISOTOPE EXCHANGE AND ISOTOPE SEPARATION	2743
PHOTOCHEMISTRY	2743
RADIATION CHEMISTRY	2743
RADIOCHEMISTRY AND NUCLEAR CHEMISTRY	2744
PROPERTIES OF RADIOACTIVE MATERIALS	2744
COMBUSTION CHEMISTRY	2744
ENGINEERING	2744
GENERAL ENGINEERING	2744
FACILITIES AND EQUIPMENT	2744
CRYOGENIC AND SUPERCONDUCTING EQUIPMENT AND DEVICES	2745
PROTECTIVE STRUCTURES AND EQUIPMENT	2745
HANDLING EQUIPMENT AND PROCEDURES	2745
MINING AND DRILLING EQUIPMENT AND FACILITIES	2745
LASERS	2745
HEAT TRANSFER AND FLUID FLOW	2751
MATERIALS TESTING	2751
VACUUM ENGINEERING	2751
ELECTRONIC CIRCUITS AND DEVICES	2751
WASTE PROCESSING PLANTS AND EQUIPMENT	2751
COMBUSTION SYSTEMS	2751
UNDERGROUND ENGINEERING	2752
MARINE ENGINEERING	2752
POLLUTION CONTROL EQUIPMENT	2753
PARTICLE ACCELERATORS	2753
DESIGN, DEVELOPMENT, AND OPERATION	2753
BEAM DYNAMICS, FIELD CALCULATIONS, AND ION OPTICS	2753
AUXILIARIES AND COMPONENTS	2754
ION SOURCES	2754
EXPERIMENTAL FACILITIES AND EQUIPMENT	2754
STORAGE RINGS	2754
INSTRUMENTATION	2756
RADIATION INSTRUMENTATION	2756
GENERAL DETECTORS AND MONITORS	2756
RADIATION DOSEMETERS	2757
NUCLEAR SPECTROSCOPIC INSTRUMENTATION	2757
HIGH ENERGY PHYSICS INSTRUMENTATION	2757
RADIOMETRIC INSTRUMENTS	2757
RADIATION EFFECTS ON INSTRUMENT COMPONENTS, INSTRUMENTS, OR ELECTRONIC SYSTEMS	2758
MISCELLANEOUS INSTRUMENTS	2758
WELL LOGGING INSTRUMENTATION	2759
EXPLOSIONS AND EXPLOSIVES	2759
CHEMICAL	2759
NUCLEAR	2759
CIVIL USES	2760
WEAPONRY	2760
EXPLOSION DETECTION	2760
ENVIRONMENTAL SCIENCES, ATMOSPHERIC	2761
BASIC STUDIES	2761
CHEMICALS MONITORING AND TRANSPORT	2762
RADIOACTIVE MATERIALS MONITORING AND TRANSPORT	2763
REGULATIONS	2763
ENVIRONMENTAL SCIENCES, TERRESTRIAL	2763
BASIC STUDIES	2763
CHEMICALS MONITORING AND TRANSPORT	2766
RADIOACTIVE MATERIALS MONITORING AND TRANSPORT	2766
SOIL	2766
TERRESTRIAL ECOSYSTEMS AND FOOD CHAINS	2767
SITE RESOURCE AND USE STUDIES	2767
REGULATIONS	2768
ENVIRONMENTAL SCIENCES, AQUATIC	2768
BASIC STUDIES	2768
CHEMICALS MONITORING AND TRANSPORT	2769
RADIOACTIVE MATERIALS MONITORING AND TRANSPORT	2769
AQUATIC ECOSYSTEMS AND FOOD CHAINS	2770
THERMAL EFFLUENTS MONITORING AND TRANSPORT	2770
SITE RESOURCE AND USE STUDIES	2770
REGULATIONS	2770
ENVIRONMENTAL-SOCIAL ASPECTS OF ENERGY TECHNOLOGIES	2770
SOCIAL AND ECONOMIC STUDIES	2770
ASSESSMENT OF ENERGY TECHNOLOGIES	2771
ENVIRONMENTAL IMPACT STATEMENTS	2771
BIOMEDICAL SCIENCES, BASIC STUDIES	2771
BEHAVIORAL BIOLOGY	2771
BIOCHEMISTRY	2771
CYTOLOGY	2772
GENETICS	2774

CONTENTS (continued)

Category	Page
METABOLISM	2774
MEDICINE	2774
TRACER TECHNIQUES	2774
MICROBIOLOGY	2775
MORPHOLOGY	2775
PATHOLOGY	2776
PHYSIOLOGICAL SYSTEMS	2776
AGRICULTURE AND FOOD TECHNOLOGY	2776
BIOMEDICAL SCIENCES, APPLIED STUDIES	2776
RADIATION EFFECTS ON CELLS	2776
EXTERNAL SOURCE	2776
BASIC STUDIES	2776
RADIATION EFFECTS ON ANIMALS	2776
MAN	2776
VERTEBRATES	2777
INVERTEBRATES	2777
RADIONUCLIDE EFFECTS - INTERNAL SOURCE	2777
MAN	2777
NUCLIDE KINETICS AND TOXICOLOGY	2777
MAN	2777
ANIMALS	2778
PLANTS	2778
MICROORGANISMS	2778
CHEMICALS METABOLISM AND TOXICITY	2778
MICROORGANISMS	2778
PLANTS	2778
INVERTEBRATES	2778
VERTEBRATES	2778
MAN	2778
OTHER ENVIRONMENTAL POLLUTANT EFFECTS	2778
HEALTH AND SAFETY	2779
GEOSCIENCES	2779
GEOLOGY AND HYDROLOGY	2778
GEOPHYSICS	2779
SEISMOLOGY AND TECTONICS	2779
VOLCANOLOGY	2780
GEOPHYSICAL SURVEY METHODS	2780
MINERALOGY, PETROLOGY, AND ROCK MECHANICS	2780
GEOCHEMISTRY	2780
OCEANOGRAPHY	2781
PHYSICS RESEARCH	2781
ASTROPHYSICS AND COSMOLOGY	2781
COSMIC RADIATION	2781
STARS	2781
QUASI-STELLAR, RADIO, AND X-RAY SOURCES	2782
SOLAR PHENOMENA	2782
GALAXIES	2782
COSMOLOGY	2782
ATMOSPHERIC PHYSICS	2782
AURORAL AND IONOSPHERIC PHENOMENA	2782
EFFECTS OF NUCLEAR DETONATIONS	2783
MAGNETOSPHERIC PHENOMENA	2784
ATOMIC, MOLECULAR, AND CHEMICAL PHYSICS	2784
BEAMS AND THEIR REACTIONS	2785
ATOMIC AND MOLECULAR PROPERTIES	2785
POSITRONIUM, MUONIUM, AND MUONIC AND MESIC ATOMS AND MOLECULES	2786
COLLISION PHENOMENA	2786
ATOMIC AND MOLECULAR THEORY	2788
GENERAL FLUID DYNAMICS	2788
PROPERTIES AND STRUCTURE OF FLUIDS	2789
MAGNETOHYDRODYNAMICS	2789
SUPERFLUIDITY	2789
PARTICLE INTERACTIONS AND PROPERTIES - EXPERIMENTAL	2789
ELECTROMAGNETIC INTERACTIONS	2789
WEAK INTERACTIONS	2790
STRONG BARYON-INDUCED INTERACTIONS	2791
STRONG MESON-INDUCED INTERACTIONS	2792
PARTICLE INTERACTIONS AND PROPERTIES - THEORETICAL	2793
GENERAL	2793
ELECTROMAGNETIC INTERACTIONS	2795
WEAK INTERACTIONS	2797
STRONG INTERACTIONS, GENERAL	2798
STRONG INTERACTIONS, BARYON NO. = 0	2799
STRONG INTERACTIONS, BARYON NO. = 1	2800
STRONG INTERACTIONS, BARYON NO. GREATER THAN 1	2800
PARTICLE INVARIANCE PRINCIPLES AND SYMMETRIES	2801
GENERAL	2801
APPLICATIONS TO ELECTROMAGNETIC AND WEAK INTERACTIONS	2802
APPLICATIONS TO STRONG INTERACTIONS	2803
FIELD THEORY	2803
SCATTERING THEORY	2807
PHYSICS RESEARCH (CONT.)	2808
NUCLEAR PHYSICS	2808
EXPERIMENTAL TECHNIQUES	2808
NUCLEAR PROPERTIES AND REACTIONS, A = 1-5, THEORETICAL	2808
NUCLEAR REACTIONS AND SCATTERING	2808
NUCLEAR PROPERTIES AND REACTIONS, A = 1-5, EXPERIMENTAL	2808
NUCLEAR REACTIONS AND SCATTERING	2808
NUCLEAR PROPERTIES AND REACTIONS, A = 6-19 THEORETICAL	2809
RADIOACTIVE DECAY	2809
NUCLEAR REACTIONS AND SCATTERING	2809
NUCLEAR PROPERTIES AND REACTIONS, A = 6-19, EXPERIMENTAL	2809
ENERGY LEVELS AND TRANSITIONS	2809
NUCLEAR REACTIONS AND SCATTERING	2809
NUCLEAR PROPERTIES AND REACTIONS, A = 20-38, THEORETICAL	2810
NUCLEAR REACTIONS AND SCATTERING	2810
NUCLEAR PROPERTIES AND REACTIONS, A = 20-38, EXPERIMENTAL	2810
ENERGY LEVELS AND TRANSITIONS	2810
NUCLEAR REACTIONS AND SCATTERING	2810
NUCLEAR PROPERTIES AND REACTIONS, A = 39-58, EXPERIMENTAL	2811
RADIOACTIVE DECAY	2811
ENERGY LEVELS AND TRANSITIONS	2811
NUCLEAR REACTIONS AND SCATTERING	2811
NUCLEAR PROPERTIES AND REACTIONS, A = 59-89, THEORETICAL	2811
NUCLEAR REACTIONS AND SCATTERING	2811
NUCLEAR PROPERTIES AND REACTIONS, A = 59-89, EXPERIMENTAL	2811
RADIOACTIVE DECAY	2811
ENERGY LEVELS AND TRANSITIONS	2812
NUCLEAR REACTIONS AND SCATTERING	2812
NUCLEAR PROPERTIES AND REACTIONS, A = 90-149, THEORETICAL	2812
ENERGY LEVELS AND TRANSITIONS	2812
NUCLEAR PROPERTIES AND REACTIONS, A = 90-149, EXPERIMENTAL	2812
RADIOACTIVE DECAY	2812
ENERGY LEVELS AND TRANSITIONS	2812
NUCLEAR REACTIONS AND SCATTERING	2813
NUCLEAR PROPERTIES AND REACTIONS, A = 150-189, THEORETICAL	2813
ENERGY LEVELS AND TRANSITIONS	2813
NUCLEAR REACTIONS AND SCATTERING	2813
NUCLEAR PROPERTIES AND REACTIONS, A = 150-189, EXPERIMENTAL	2813
RADIOACTIVE DECAY	2813
ENERGY LEVELS AND TRANSITIONS	2813
NUCLEAR REACTIONS AND SCATTERING	2814
NUCLEAR PROPERTIES AND REACTIONS, A = 190-219, EXPERIMENTAL	2814

Category	Page
ENERGY LEVELS AND TRANSITIONS	2814
NUCLEAR REACTIONS AND SCATTERING	2814
NUCLEAR PROPERTIES AND REACTIONS, A=220 AND ABOVE, THEORETICAL	2814
SPONTANEOUS AND INDUCED FISSION	2814
NUCLEAR PROPERTIES AND REACTIONS, A=220 AND ABOVE, EXPERIMENTAL	2814
SPONTANEOUS AND INDUCED FISSION	2814
NUCLEAR THEORY	2815
NUCLEAR STRUCTURE	2815
NUCLEAR REACTIONS AND SCATTERING	2815
RADIATION AND SHIELDING PHYSICS	2816
RADIATION PHYSICS	2816
NEUTRON INTERACTIONS WITH MATTER	2816
DOSIMETRY	2817
SOLID STATE PHYSICS	2817
SUPERCONDUCTIVITY	2817
ACOUSTIC, ELECTRIC, MAGNETIC, OPTICAL, AND THERMAL PHENOMENA	2817
THEORETICAL PHYSICS	2817
GENERAL AND MISCELLANEOUS	2817
CLASSICAL AND QUANTUM MECHANICS	2817
RELATIVITY AND GRAVITATION	2817
STATISTICAL PHYSICS AND THERMODYNAMICS	2818
ELECTRICITY AND MAGNETISM	2818
MATHEMATICAL PHYSICS	2818
COMMUNICATION, EDUCATION, HISTORY, AND PHILOSOPHY	2819
FUSION ENERGY	2819
PLASMA RESEARCH	2819
PLASMA CONFINEMENT AND HEATING	2819
PLASMA DIAGNOSTICS	2823
PLASMA KINETICS - GENERAL	2824
PLASMA KINETICS - EXPERIMENTAL	2825
PLASMA KINETICS - THEORETICAL	2826
PLASMA PRODUCTION	2829
PLASMA INSTABILITIES	2829
PLASMA WAVE PHENOMENA	2832
FUSION POWER PLANT TECHNOLOGY	2834
BLANKET ENGINEERING	2836
MAGNET COILS AND FIELDS	2839
POWER SUPPLIES, ENERGY STORAGE	2840
COOLING SYSTEMS	2841
HEATING AND FUELING SYSTEMS	2841
POWER CONVERSION SYSTEMS	2843
INERTIAL CONFINEMENT TECHNOLOGY	2843
COMPONENT DEVELOPMENT AND MATERIALS TESTING	2845
GENERAL AND MISCELLANEOUS	2847
MATHEMATICS AND COMPUTERS	2847
INFORMATION HANDLING	2848
CORPORATE INDEX	1C
AUTHOR INDEX	17A
SUBJECT INDEX	57S
REPORT NUMBER INDEX	165R
CONTRACT NUMBER INDEX	160CN

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ENERGY RESEARCH ABSTRACTS

COAL AND COAL PRODUCTS

REFER ALSO TO CITATION(S) 26496, 26505

PROCESSING

REFER ALSO TO CITATION(S) 26194

25615 (FE—2286-25) **Preparation of a coal conversion systems technical data book. Project 8979 monthly status report, November 1—November 30, 1977.** (Institute of Gas Technology, Chicago, Ill. (USA)). 1977. Contract EX-76-C-01-2286. 64p. Dep. NTIS, PC A04/MF A01.

The real gas properties of benzene, compressibility factor, activity coefficient, and residual thermodynamic functions, are presented. Potential synthetic sorbents for absorbing sulfur dioxide in fluidized-bed combustors have been reviewed and discussed. An attempt is made to correlate the amount of water produced by pyrolysis with the oxygen content of coal. Four correlations for bituminous and lignite coals are presented and discussed. Pressure-drop correlations for horizontal dilute-phase transport of solids in gas are reviewed and six of them are selected for detailed evaluation. For coal-solvent slurry heating, the calculated bulk fluid temperatures using Sieder-Tate correlation are compared with the experimental data from the SRC pilot plant at Wilsonville, Ala.

25616 **Electrical induction heating: a new concept in in situ recovery.** Fisher, S.T. (F.T. Fisher's Sons Ltd., Montreal). *Energy Process./Can.;* 70: No. 1, 42-46, 48(1977).

The new processes involve little or no surface disturbance, no hydraulic, shale, or sand tailings, and a minimum of thermal pollution. Processes proceed with no regard to the weather. There is no requirement for water supply, but water derived from the deposit can be disposed of to ecological advantage. The sulfur problem is unchanged. The surface plant can be located directly over the deposit. Where the deposit occurs in several layers separated by sedimentary materials, it can be worked as readily as an equivalent thick seam. There is no human hazard at the surface or in the central shaft from the electromagnetic field.

CARBONIZATION

25617 (GFERC/RI—77/3) **Effect of charge preheat on the physical quality of coke from three Western coals.** Boley, C.C.; Fegley, M.M.; Porter, R.B. (Department of Energy, Grand Forks, N.Dak. (USA). Grand Forks Energy Research Center). Feb 1978. 23p. Dep. NTIS, PC A02/MF A01.

Compared with coking coals from the Eastern United States coal fields, Western coals do not produce a strong, high quality coke. They can be used to produce cokes acceptable for blast furnace use, however, by use of selective blending with premium medium- and low-volatile bituminous coals. Reserves of satisfactory blending coals in the Western United States are limited, and no minable reserves of low-volatile bituminous coal are known to exist in the West. Consequently, alternative methods by which coke from Western coals can be improved in quality are of industrial interest. Among possible alternatives is the use of inerts, such as anthracite fines, coke breeze, petroleum coke, and char, as partial or complete substitutes for blending coals. Another possible means of improving coke quality is the preheating of coal immediately before charging to the oven, which has been shown to be particularly advantageous for some weaker coking coals. Advantages that have been indicated include reduced need for blending coal, reduced coking time (which leads to shorter coking cycles and higher coke production), and reduced emission of pollutants. The effect of preheating coke-oven charges on coke quality and coking time was determined for three Western coking coals and one coal/char blend. Three levels of preheat temperature and one control level without preheat were used. In all instances tested, coke quality was improved through preheating, and coking time reduced. Effects of char addition and preheating on coke quality are partially additive.

25618 **Coking tests for Japanese coal blends by preheated-charging method.** Ozaki, K.; Tsugeno, H.; Inoue, S.; Ono, F.; Sugiyama, K.; Asahara, K. *Kawasaki Giho;* No. 63, 174-180(Mar 1977). (In Japanese).

In order to investigate the quantitative effect of coal preheating before coking on Japanese coal blends, 20 coking tests were carried out for 5 blends which were prepared from 8 individual coals; at the Marienau Experimental Station (SEM) in France. The following essential merits of preheated-charging of the Japanese coal blends at about 250°C in comparison with conventional moist-charging have been confirmed: (1) The potential coke-making capacity per oven is increased by about 50%, (2) The coke quality is improved and more uniform coke can be obtained, and therefore; (3) 5 to 10% of noncoking steam-grade coal can be used instead of high-grade coking coals for making metallurgical coke.

DESULFURIZATION AND PURIFICATION

REFER ALSO TO CITATION(S) 25665, 25717

HYDROGENATION

REFER ALSO TO CITATION(S) 25653, 25664

25619 (FE-MIT—2295T26-3) **Basic studies of coal pyrolysis and hydrogasification. Quarterly progress report, July 1, 1977—September 30, 1977.** Bush, T.W.; Denholm, D.; Franklin, H.; Howard, J.B.; Kenda, S.; Mead, D.; Peters, W.A.; Suuberg, E.M. (Massachusetts Inst. of Tech., Cambridge (USA)). Nov 1977. Contract EX-76-C-01-2295-026. 4p. Dep. NTIS, PC A02/MF A01.

Most of the work in this quarter focussed on expanding the data base on hydropyrolysis, especially for the Pittsburgh No. 8 bituminous coal. For both coals, hydrogen at 69 atm and 1000°C at long residence times effected 3 to 10 fold increases in CH_4, C_2H_6 and C_3-C_5 hydrocarbon yields compared to low pressure pyrolysis in helium but caused C_2H_4 yields to decrease by a factor of two to three. One of the most interesting findings was that in the 850 to 1000°C temperature range and for solids residence times of order 10 to 20 s, hydrogen at 69 atm gave, for the lignite, a modest increase in tar yield compared to the 1 atm rapid pyrolysis in inert gas case (from approximately 5.4 to approximately 8 wt%, as received basis) but, for the bituminous coal, tar yield decreased by almost a factor of two (from approximately 23 to approximately 12 wt%, as received basis). Particle size effects in coal hydropyrolysis were also studied. The improvements in the Laminar Entrained Flow Reactor have had a positive effect on operating performance and acceptable material balance closures are beginning to be obtained.

GASIFICATION

REFER ALSO TO CITATION(S) 25674, 26144, 26543

25620 (AD-A—042385) **Coal gasification study handbook. Final report.** (Bechtel Corp., San Francisco, Calif. (USA)). Apr 1977. Contract N68305-76-C-0009. 103p. Corp., San Francisco.

The purpose of this handbook is to provide: first, a procedure for evaluating the costs of a coal gasification plant in terms of the capital investment and operating costs. These are to be sensitive to

several parameters defining coal, fuel gas, and sulfur emissions; second, a procedure for the derating of Navy base boilers, to reflect the change in performance resulting from introduction of fuel gas in place of coal or oil. The gas plant analysis is based in part on a detailed analysis of the gas treatment section of the plant. The remaining part of the plant performance is based on conventional stoichiometry and near approach to equilibrium in the gas production section. The boiler derating method is based on observations of the relative contribution to heat transfer made by radiation and convection, and on conventional relations describing these transfer processes.

25621 (ANL/MSD/FE—77-6R) **Failure of the thermocouple assembly from the HYGAS coal pretreatment vessel: failure analysis report.** Danyluk, S.; Dragel, G.M. (Argonne National Lab., Ill. (USA)). Jul 1977. Contract W-31-109-ENG-38. 21p. Dep. NTIS, PC A02/MF A01.

A thermocouple assembly from the HYGAS coal-gasification pilot plant failed by melting near the hot junction of the iron-constantan thermocouple. The assembly, with a Type 310 stainless steel protection tube, is used to monitor temperatures in the coal pretreatment vessel. Severe oxidation and sulfidation were found at the scale on the outside diameter (OD) of the protection tube. The causes of the failure were the formation of low melting point nickel and iron sulfide eutectics at the grain boundaries and exposure to excessive deviation from specified temperatures. The failure is believed to be similar to a previous one that occurred in the same location, which was analyzed by J. Y. N. Wang in June 1976. As estimated in that report, temperatures in excess of 900°C (1652°F) were reached in the heavily reacted zone and the deposition of clinker (pretreater coal product formed under off-design conditions) reduced the effectiveness of the protection tube, affected the microstructure, and aggravated the failure.

25622 (CONF-770814—12) **Search for a new coal technology.** Schora, F.C. (Institute of Gas Technology, Chicago, Ill. (USA)). 1977. 7p. of Gas Technology, Chicago.

From American Chemical Society meeting; Chicago, IL, USA (29 Aug 1977).

Pertinent highlights of progress in coal chemistry are reviewed beginning in 1660 when coal was distilled in a laboratory experiment for the first time to yield a combustible gas. The significance of advances in coal chemistry are related to the steady technological advance of mankind, starting with the Industrial Revolution and progressing to the present. Among the institutions generated from this progress have been the Gas Industry, Iron and Steel Industry, and the Organic Chemical Industry. Modern coal conversion processes utilize the same basic coal chemistry as in the past, bringing about advances through chemical engineering. Mr. Schora concludes with a strong appeal for the establishment of some mechanism that will guarantee the exploration of coal chemistry so that future developments can benefit not only from chemical engineering advances, but from more subtle advances in chemistry, as well.

25623 (CONF-771092—9) **Operating experience with the IGT cold-gas recycle methanation process in the HYGAS pilot plant.** Leppin, D. (Institute of Gas Technology, Chicago, Ill. (USA)). 1977. 17p. of Gas Technology, Chicago.

From 9. synthetic pipeline gas symposium; Chicago, IL, USA (31 Oct 1977).

The IGT cold-gas recycle methanation process pilot plant unit has been operated over 1000 hours. In these tests, no difficulty in operating or controlling the process has ever been observed. Conversion of CO has been complete in all cases. No problems with hot spot formation or carbon deposition have occurred. The principal difficulties have involved the sulfur deactivation of nickel-based catalysts. Steps have been taken to insure that lower levels of sulfur will be admitted to the system in the future. Further work will focus on testing additional catalysts to find those with optimal properties for methanation processes in large scale coal gasification facilities.

25624 (CONF-780305—10) **Environmental aspects of the HYGAS Process.** Anastasia, L.J.; Bair, W.G.; Olson, D.P. (Institute of Gas Technology, Chicago, Ill. (USA)). 1978. 13p. of Gas Tech., Chicago, IL.

From Division of fuel chemistry meeting; Anaheim, CA, USA (12 Mar 1978).

Sampling of pilot plant streams specifically for environmental assessment began with Test 55 with Montana subbituminous coal. Process water streams were sampled every 8 hours and three of these samples were composited to represent 24 hours of plant operation. Water samples were analyzed for total dissolved solids (TDS), total suspended solids (TSS), total organic carbon (TOC), total phenols, total sulfur, ammonia, cyanide, thiocyanate, sulfide, chloride, and oil. Solids samples were collected once per day and analyzed for sulfur species and trace elements. The solids streams sampled included the coal feed, the first and second stages of gasification, and the spent char. Samples of oils in the coal feed slurry were also taken once per day to determine organic compositions using a gas chromatograph mass spectrometer.

25625 (CONF-7710116—1) **Low-Btu gas as an industrial energy source.** Schora, F.C.; Loeding, J.W. (Institute of Gas Technology, Chicago, Ill. (USA)). 1977. 29p. of Gas Technology, Chicago, IL.

From Low-btu gas) its future; Dundee, IL, USA (2 Oct 1977).

The lower-value fuel gases are needed to extend the supplies of natural gas and thus make natural gas available for higher-priority uses for a longer period. The gases provide one way to convert coal to an environmentally acceptable energy source. Today, for example, the combustion products of directly combusted coal contribute one-eighth of the total atmospheric pollutants emitted in the United States, including one-half of the sulfur oxides and one-quarter of both the nitrogen oxides and the particles. Coal gasification provides one means by which these pollutants can be minimized. Several coal-gasification processes are described briefly, and U. S. ERDA's demonstration plant program is discussed.

25626 (EPRI-FP—539) **Thermodynamic phase stability diagrams for the analysis of corrosion reactions in coal gasification/combustion atmospheres. Interim report.** Hemmings, P.L.; Perkins, R.A. (Lockheed Missiles and Space Co., Palo Alto, Calif. (USA). Lockheed Palo Alto Research Lab.). Dec 1977. 110p. Dep. NTIS, PC A06/MF A01.

An improved understanding of corrosion chemistry in complex environments is needed for the effective use of metals and alloys in coal gasification/combustion systems. High-temperature corrosion reactions can be analyzed effectively if considered first from a thermodynamic equilibrium point of view. The equilibriam pressure of sulfur, oxygen, nitrogen and carbon in the gas will determine which condensed phases can stand in equilibrium with the gas. Reaction paths can be charted to determine how other phases can exist beneath the surface scale. The use of thermodynamic phase-stability diagrams for this purpose is discussed. The diagrams show which phases can exist at a given temperature for a given element (Fe, Ni, Co, etc.) in a mixture of two different oxidants (C, O, S, and N). The derivation and use of these diagrams to interpret behavior in coal gasification/combustion atmospheres is discussed. Diagrams for Fe, Ni, Co, Cr, Al, and Mn in S—O, C—O, N—O, C—S, C—N, and S—N mixtures at 894, 1144, and 1366 K (1150, 1600, 2000°F) are presented in the report. Thermodynamic data used to derive the diagrams are also given.

25627 (FE—1207-40) **Gas generator research and development BI-GAS Process. 76th monthly progress report, December 1977.** (Bituminous Coal Research, Inc., Monroeville, Pa. (USA); Phillips Petroleum Co., Homer City, Pa. (USA)). Jan 1978. Contract EX-76-C-01-1207. 39p. Dep. NTIS, PC A03/MF A01.

The life test of catalysts BCR Lots No. 3948, 3949, 3964, and 3965 was terminated after 530 hours, rather than the usual 800 hours, because of the low activity of all four samples. The deactivation of catalysts No. 3948 and 3949 was unusually abrupt, occurring early in the test following the initial treatment at 800 F and 1100 F. Catalysts 3964 and 3965 had been submitted as improvements over two other catalysts tested a year earlier. Initial conversions were an improvement over the earlier catalysts, but the long-term performance was not significantly better. Processing of the data from PEDU Test No. 27 has been delayed because of major discrepancies in preliminary mass balance results, and continuing efforts to determine why the activity of the catalyst was so much lower than normal during this PEDU test. The discrepancies in the mass balances are believed to be due primarily to pressure fluctuations caused by condensation of carbon dioxide following Joule-Thomson expansion of the product gas through the reactor back pressure control valve. The addition of electrical heat tracing to the product gas piping appears to alleviate the problem. The cause for the low activity of the catalyst has not yet been determined. No significant differences in metal loadings, sulfur contents, or BET surface areas were detected in the samples analyzed. It is possible that the carbon content of the as-charged catalyst was sufficiently high to inhibit normal activity. This is being investigated further through the initiation of a bench-scale activity test in the life test reactor. Analytical and computer services continued in support of the overall program.

25628 (FE—1514-73) **Advanced coal gasification system for electric power generation. Sixty-third monthly progress report, October 1977.** Keairns, D.L.; Salvador, L.A. (Westinghouse Electric Corp., Lester, Pa. (USA). Generation Systems Div.). 30 Nov 1977. Contract EX-76-C-01-1514. 13p. Dep. NTIS, PC A02/MF A01.

Operation of the gasifier process development unit in tests TP-012-5 and TP-012-6 is reported. The reactor was then cleaned and prepared for TP-014, which is to be a feasibility demonstration with PDU and FMC chars. Several supporting studies are described briefly. Cracks in the Incoloy 800 lines were due to stress corrosion. In one area 304SS was substituted for Incoloy 800, but eventually Incoloy 825 will be used for all high-temperature process lines because of its resistance to stress corrosion cracking. (LTN)

25629 (FE—1545-39) **Study of plant metallurgical requirements for low-Btu gasification of coal for electric power generation.** Lewis, E.C. (Combustion Engineering, Inc., Windsor, Conn. (USA)). Jun 1977. Contract EX-76-C-01-1545. 99p. Dep. NTIS, PC A05/MF A01.

Materials of construction were evaluated for the Combustion Engineering-ERDA, atmospheric pressure, entrained bed, coal gasification system. Incorporating a review of pertinent published literature supplemented with the results of laboratory corrosion tests, the evaluation indicated that the materials used for conventional pulverized coal-fired utility boiler components (carbon and low alloy steels) should perform satisfactory in the gasifier of the 5-ton per hour Process Development Unit (PDU). However, for commercial-scale plants utilizing heat absorption surfaces at higher design temperatures, conventional materials may experience excessive wastage from corrosion by hydrogen sulfide in the gas. Short term tests of coatings on low carbon steel in this task showed promise as possible candidates for commercial installations. These coatings are to be evaluated further during operation of the PDU.

25630 (FE—2218-15) **Improvement of the mechanical reliability of monolithic refractory linings for coal gasification process vessels. Bimonthly letter progress report, October—November 1977.** Anderson, E.M. (Babcock and Wilcox Co., Lynchburg, Va. (USA)). Dec 1977. Contract EX-76-C-12-2218. 11p. Dep. NTIS, PC A02/MF A01.

The third liner was cast without anchors in view of the high degree of cracking found around the anchors in post test inspection of liners 1 and 2. Fabrication of the third liner proceeded satisfactorily, but in heat-up, in the range of 800 to 1000°F, a large crack propagated in an explosive manner. Stress, strain, temperature data and acoustic emission results have been reduced and plotted. Difficulties in obtaining high temperature strain gages for this work are described. (LTN)

25631 (FE—2240-79) **Quarterly technical progress report, October—December 1977.** Detman, R. (Braun (C.F.) and Co., Alhambra, Calif. (USA)). Jan 1978. Contract EX-76-C-01-2240. 18p. Dep. NTIS, PC A02/MF A01.

Monitoring of pilot plant operations continued at HYGAS, BI-GAS and Synthane. The final run at the CO_2 Acceptor plant was covered and a trip report issued. HYGAS operations continued to establish design conditions on Illinois coal from the Peabody mine. The BI-GAS plant established conditions with addition of limestone flux to achieve successful tapping of slag from Stage I. Synthane has made numerous attempts to pretreat eastern bituminous coal without success. They next plan to increase the superheat of steam used in transporting coal to the pretreater. Several process studies on gasification operations were completed and published. Work continued on other studies in methanation and on factors influencing the selection of plant size. Work was begun on alternative cases for the eastern coal commercial concepts to establish the effect of ground rule changes on the cost of gas. A special study comparing HYGAS processes using the revised ground rules and process improvements was completed as well as a comparative study of Steam-Iron and Koppers-Totzek for hydrogen production. Work continued on the commercial concept designs using a lignite feed for the CO_2 Acceptor and Lurgi processes.

25632 (FE—2247-9R) **Gasification of residual materials from coal liquefaction. Evaluation of SRC II vacuum flash drum bottoms as feedstock to the Texaco Coal Gasification Process.** Robin, A.M. (Texaco, Inc., Montebello, Calif. (USA). Montebello Research Lab.). Aug 1977. Contract EX-76-C-01-2247. 12p. Dep. NTIS, PC A02/MF A01.

A laboratory evaluation of a 20-pound sample of Vacuum Flash Drum Bottoms from the SRC II plant in Tacoma, Washington was completed at Texaco's Montebello Research Laboratory. The sample, which was obtained from the liquefaction of Kentucky No. 9 and 14 coal, was judged to be a suitable feedstock for the Texaco Coal Gasification Process. It can be charged directly to the gasifier at a temperature of about 700°F. The material is too viscous to be pumped with the pilot plant equipment, however, which is capable of maintaining a temperature of only 510°F. The addition of 10 to 20 percent aromatic cutter will be required if pilot plant tests are desired. No cutter will be required for a commercial plant. Based on these results, operating conditions and yields were estimated for gasifying 1000 pounds per hour of molten undiluted residue at 350 psig. A Type II preliminary pilot plant evaluation is recommended if ERDA will agree to the addition of aromatic solvent or other suitable cutter to the residue.

25633 (FE—2286-20) **Preparation of a coal conversion systems technical data book. Project 8979 quarterly report, May 1—July 31, 1977.** (Institute of Gas Technology, Chicago, Ill. (USA)). Nov 1977. Contract EX-76-C-01-2286. 171p. Dep. NTIS, PC A08/MF A01.

Methods of calculation of gas-phase fugacities, required in the analysis of equilibrium data on NH_3-CO_2-H_2S-H_2O system, are discussed. Vapor-liquid equilibrium in NH_3-H_2S-H_2O subsystem is investigated further. Various correlations for estimating the calorific value of coal from its elemental composition are evaluated per se and by use of the modified Parr basis for mineral matter correction. The formulas are also applied separately to different ranks of coal as a step toward finding the best correlation. Enthalpy data of a coal liquid (Western Kentucky syncrude) are given as a function of temperature and pressure. Phase compositions and vapor pressures in 3-phase equilibrium of cyclohexane-water system are presented. Sulfation and regeneration of the acceptor (limestone, dolomite) in fluidized-bed combustion are investigated. The problems of predicting absorbent (acceptor) activity are discussed. A correlation between tar-plus-light oil yield and total conversion for pyrolysis of Western subbituminous coals and lignites is presented. Equilibrium constants for various reactions encountered in coal conversion processes are presented. Fate of trace elements in coal gasification is discussed. Some new data on heat transfer coefficients to a single tube and tube bundles in fluidized-bed reactors are reported. Results of tests to evaluate performance of insulating materials in atmospheres expected in coal conversion reactors are given.

25634 (FE—2336-17) **Modification and operation of the atmospheric ash-agglomerating gasifier on coal. Project 9020 monthly progress report, October 1977.** Sandstrom, W.A. (Institute of Gas Technology, Chicago, Ill. (USA)). Dec 1977. Contract EX-76-C-01-2336. 28p. Dep. NTIS, PC A03/MF A01.

Two test runs were conducted with the AAG reactor system during October. In Run 111, Montana subbituminous coal was successfully gasified at approximately 90% conversion efficiency. This high efficiency was attained through continuous operations by recycling the fines elutriated from the reactor back to the fluidized bed. The high reactivity of this coal again reduced the operating bed temperature, which inhibited ash agglomerate formation. The supply of subbituminous coal was exhausted with the completion of Run 111. Run 112 was conducted with a higher rank coal (Illinois bituminous), readily available in a crushed and dried form, while awaiting delivery of three cars of a Utah bituminous coal. The 60-hour test yielded a bed temperature 100° to 150°F higher than achievable with the subbituminous coal. Also of equal importance was the successful continuous fluidization of this caking coal coupled with the production of a fuel gas completely free of tars or condensibles. Work continues with the Illinois coal to establish ash agglomerating conditions.

25635 (FE—2340-4) **Improved techniques for gasifying coal. Fourth quarterly report, April 1—June 30, 1977.** Graff, R.A.; Yerushalmi, J. (City Coll., New York (USA)). Jul 1977. Contract EX-76-S-01-2340. 48p. Dep. NTIS, PC A03/MF A01.

Studies of high velocity fluidized beds continued in the modified 6-inch and two-dimensional systems. The 6-inch unit was modified to test a new mode of feeding solid from the slow bed to the 6-inch column. Control of the solid rate is now effected by a newly constructed cone valve. Preliminary results indicate that the new transfer line performs well. The modified system includes a newly constructed primary cyclone. The two-dimensional bed was modified to enable quantitative study of the regimes of fluidization and the transition between them. The study of gas backmixing was completed and the results are described herein. The extent of gas backmixing generally diminishes with increasing gas velocity, and is practically negligible in the fast fluidized bed. During previous experiments conducted in the 6-inch unit with FCC to determine the overall capture efficiency of the primary cyclone, the two solid streams leaving the primary cyclone were frequently sampled and later subjected to size distribution analysis. The results are summarized. Thirteen additional runs on U.S. coals were made. This completes the experimental data for a comparative study of these coals. Six runs were made with reactor tubes gold plated on their inside surfaces to check for catalytic wall effects. No substantial catalytic effect was observed. A short study of yields obtainable at short residence time (0.18 seconds) and high temperature (up to 955°C) was made. The results compare well with those published by Rockwell International. At 955°C the total liquid yield is high (over 40% carbon conversion) but low in BTX (4% carbon conversion).

25636 (FE—2433-17) **Environmental assessment of the HYGAS Process. Project No. 9025 monthly progress report, July 1—July 31, 1977.** (Institute of Gas Technology, Chicago, Ill. (USA)). Dec 1977. Contract EX-76-C-01-2433. 12p. Dep. NTIS, PC A02/MF A01.

After a formal review and critique of the comprehensive test plan for the environmental assessment of the HYGAS Process, a major effort is under way to revise and update the test plan based on initial program objectives, on the interpretation of experimental data already accumulated, and on the coordination of activities in the HYGAS program with assessment programs at other coal gasification pilot plants. The test plan will emphasize the acquisition of environmental data, which are most suitable for describing projected emissions from demonstration and commercial plant designs. Pollutant production in the various HYGAS water streams is reported on a normalized basis (pounds of species per ton of pretreated char to the gasifier) for HYGAS Tests 61 and 62 using Illinois No. 6

bituminous coal. The gasification of sulfur during Tests 61 and 62 is reported as a function of species and reaction stage. These data indicate that approximately 28% of the sulfur was released during pretreatment, 39% during the first stage of gasification, 5% during the second stage of gasification, and 24% during the steam-oxygen reaction.

25637 (FE—2433-18) **Environmental assessment of the HYGAS Process. Project No. 9025 monthly progress report, August 1—August 31, 1977.** (Institute of Gas Technology, Chicago, Ill. (USA)). Dec 1977. Contract EX-76-C-01-2433. 12p. Dep. NTIS, PC A02/MF A01.

After a formal review and critique of the comprehensive test plan for the environmental assessment of the HYGAS Process a major effort is under way to revise and update the test plan based on program objectives, on the interpretation of experimental data already accumulated, and on the coordination of activities with assessment programs at other coal gasification pilot plants. The test plan will emphasize the acquisition of environmental data which are most suitable for evaluating projected emissions from demonstration and commercial plant designs. Pollutant production rates determined from wastewater compositions and process material balances are reported for Test 63 with Illinois No. 6 bituminous coal. The results are similar to those reported previously for Tests 61 and 62. Sulfur analyses by species across the pretreater and gasifier are reported for Test 63. The organic sulfur species appears to be the least reactive and accounts for 82.5% of total sulfur remaining in the spent char. For Test 63, the total sulfur removed across the pretreater (23.5%) and across both the pretreater and the gasifier (93.4%) were comparable with results in Tests 61 and 62. A RAC-3 gas sampling system has been purchased primarily to determine sulfur dioxide concentrations in selected process streams. The system can use wet-chemical absorption techniques to analyze for three different species in gas streams. The system will be used to sample for sulfur dioxide (SO_2), nitrogen dioxide (NO_2), hydrogen sulfide (H_2S), ammonia (NH_3), aliphatic aldehydes (R-CHO), and possibly for other gases. Laboratory experiments have continued with simulated process gas mixtures to determine the effects of shift reactions on pollutant levels.

25638 (FE—2468-18) **ESCOE engineering program. Quarterly report, September 1—November 30, 1977.** Hill, R.F. (Engineering Societies Commission on Energy, Inc., Washington, D.C. (USA)). Jan 1978. Contract EF-77-C-01-2468. 14p. Dep. NTIS, PC A02/MF A01.

Three technical tanks have been chosen for ESCOE's initial investigations. The objectives for task No. 2 have crystallized into two different areas: (1) a process review to confirm that the reactor conditions being developed for the various projects include the combinations expected to yield optimum results, and (2) an economic review with particular emphasis on capital costs estimates since these become a major portion of the production costs. Work is under way on obtaining cost information for each process. A consistent approach to plant capital estimates beginning with simple descriptions of the major process equipment is being developed. The objective of task No. 3 is to develop a simple, yet effective, ESCOE/DOE information system. The provision of technical services to DOE requires that ESCOE engineers have ready access to technical information developed by DOE and the technical community in general. This in turn requires that ESCOE develop and maintain an information retrieval capability. The ESCOE/DOE technical information base will be defined, information and selection retrieval methods will be designed, and technical documentation standards will be established. Progress on this task includes: (1) development of an expanded task work scope, (2) development of a preliminary fossil energy information base outline, (3) initial review of other DOE programs for inclusion in the information base, (4) initial definition of information systems at the Electric Power Research Institute, National Bureau of Standards, National Technical Information Service, and Systems Development Corporation, and (6) preliminary draft of the report on ESCOE needs and DOE resources. The objective of task No. 4 is to conduct a review of non-fossil energy development programs to determine the feasibility of technology transfer or joint program development.

25639 (FE—2565-10) **Analysis of coal hydrogasification processes. Monthly technical progress report, 1 December—31 December 1977.** (Bechtel Corp., San Francisco, Calif. (USA)). Jan 1978. Contract EF-77-A-01-2565. 29p. Dep. NTIS, PC A03/MF A01.

Data from 12 recent Cities Service tests using subbituminous coal were entered into the computerized data base. The measured conversions and selectivities for the recently completed tests were in good agreement with the correlations developed from previous Cities Service tests on subbituminous coal. A semiempirical correlation for predicting overall carbon conversion efficiency was fitted to the Brookhaven lignite hydropyrolysis data. Because of inconsistencies in the data, 11 of the 48 runs were not used in the correlation. The results showed that carbon conversion was a significant function of reactor temperature and hydrogen partial pressure over the region investigated. The correlation fitted to the previous Cities Service subbituminous data did not satisfactorily predict the lignite carbon conversion efficiencies obtained by Brookhaven.

25640 (MIT—78-TR3) **Review and evaluation of failures, maintenance, and operability data for CO_2 Acceptor Plant mechanical equipment.** McGee, M.P.; McCabe, J.T. (Mechanical Technology, Inc., Latham, N.Y. (USA)). 10 Oct 1977. Contract EF-77-C-01-2615. 28p. Dep. NTIS, PC A03/MF A01.

The following conclusions summarize the evaluation: Very few rotating machinery problems were encountered because good equipment was purchased and because the plant was designed for 300 psig but was operated at 150 psig. In scale-up, many of the critical compressors will not be reciprocating compressors as were used in CO_2 Acceptor Pilot Plant; they will be centrifugal or axial compressors. A significant percent of the recycle gas compressor maintenance could be eliminated by improving the performance of the knock-out pots and filters. The problem with the two compressors that operated at excessive gas discharge temperatures could have been avoided by stating the number of intercooled stages that must be provided by the vendor in the initial purchase specification. Bag houses continue to remain the weak point of coal pulverizing and drying systems. The bags have poor tolerance to upsets in process parameters and can shut down the plant if they fail. A two-stage drying system would provide better control of the mill circuit temperature and thereby help protect the bag house. A power recovery turbine making use of the Regenerator flue gas at a minimum temperature of 1000°F should be incorporated into the process to drive the regenerator air compressor.

25641 (PB—270913) **Fate of trace and minor constituents of coal during gasification. Final task report.** Attari, A.; Pau, J.; Mensinger, M. (Institute of Gas Technology, Chicago, Ill. (USA)). Sep 1976. Contract EPA-68-02-1307. 46p. NTIS PC A03/MF A01.

The report gives results of a study of the fate of selected minor and trace elements of Montana lignite and Illinois No. 6 bituminous coals during development of the HYGAS process. Solid residue samples from various development stages were analyzed. The data indicate that certain volatile trace elements are removed from the coal during gasification. Removed from the solids during processing were such elements as antimony, arsenic, bismuth, cadmium, chlorine, fluorine, mercury, lead, selenium, and tellurium. It is estimated that, in a full scale operation, these will appear in the quench water system.

25642 (TID—28182) **Fossil energy demonstration plants.** (Department of Energy, Washington, D.C. (USA)). Nov 1977. 16p. Dep. NTIS, PC A02/MF A01.

The goal of the Fossil Energy Demonstration Plant Program is to initiate projects that will produce the information required to commercialize the conversion of domestic coal resources into environmentally and socially acceptable substitutes for oil and natural gas. In processing fossil fuels, the plant size needed for acceptable economics is very large. Capital requirements are therefore large and the time from conceptual design to capacity operation and process evaluation is long. Pilot plant data and marketing data often cannot be extrapolated with any degree of confidence over such a long period. Consequently, a satisfactory return on the investment at an acceptable risk cannot now be assured if the commerical plant is brought on stream immediately. For this reason, the Department of Energy (DOE) felt the need for the demonstration plant as an intermediate step between the pilot plant and the commercial plant. The program encourages private industry to become Industrial Partners who will direct projects and share the risks and costs of demonstrating unproven but potentially viable fossil energy conversion and utilization technologies. The industrial partner directs all design, construction and operation. Demonstration plant projects in the program areas of Fuel Gas and Pipeline Gas are described.

25643 (TID—28187) **Development and evaluation of high chromium weld deposited overlays to protect less alloyed substrates from corrosion in a coal gasification atmosphere. Technical status report, December 1—December 31, 1977.** (International Nickel Co., Inc., Suffern, N.Y. (USA). Paul D. Merica Research Lab.). 19 Jan 1978. Contract EF-77-C-01-2621. 13p. Dep. NTIS, PC A02/MF A01.

High chromium alloy was deposited on stainless steel-304L by three welding methods and the overlayed samples subjected to bend tests, chemical analysis (of both the base metal and the overlay). The dilution of the base metal and the recovery of the major alloying elements (Cr, Ni, Mn, Si, G, P and S) in the deposited weld metal were calculated. (LTN)

25644 (UCRL—80145) **Effects of underground coal gasification on ground-water quality.** Campbell, J.H.; Dalton, V. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 5 Dec 1977. Contract W-7405-ENG-48. 13p. (CONF-780305—9). Dep. NTIS, PC A02/MF A01.

From Division of fuel chemistry meeting; Anaheim, CA, USA (12 Mar 1978).

Ground water was sampled and analyzed at the site of the Hoe Creek in-situ gasification site before and at 3, 83, 182 and 280 days following gasification. The electrical conductivity afterwards was higher by a factor of 2 within 10 feet of the burn but approached baseline values at 100 feet. The electrical conductivity continued to drop with time. Detailed results are given for sulfate ions, cyanide ions and phenols. The transport rate of phenols through coal was very low since the material is strongly adsorbed. (LTN)

25645 Coal chemistry or/instead of coal combustion. *Nachr. Chem., Tech. Lab.;* **25**: No. 5, 227-232(May 1977). (In German).

The return to the raw material basis of coal to yield chemical raw materials, the necessary adaptation and new development of methods to process coal and important process steps to produce basic chemicals are discussed. The world-wide development in construction and operation of new plants is discussed.

25646 Art of coal gasificaion. Rudolph, P.F.H. (LURGI Mineraloeltech, Frankfurt AM, Ger). *Chem. Age India;* **28**: No. 4, 257-267(Apr 1977).

This survey examines the various gasification systems, the three main groups of reactors, when to use counter-current or co-current operation, the influence of the ash, supplying reaction heat, as well as a description and performance data for the various processes.

LIQUEFACTION

REFER ALSO TO CITATION(S) 25622, 25632, 25633, 25638, 25667, 26519

25647 (EPRI-AF—579) Evaluation of materials for use in letdown valves and coal feed pumps for coal liquefaction service. Final report. Mueller, J.J.; Wright, I.G. (Battelle Columbus Labs., Ohio (USA)). Jan 1978. 87p. Dep. NTIS, PC A04/MF A01.

The erosion test apparatus was modified to provide conditions more closely simulating those of the SRC pilot liquefaction facility for evaluation of materials for letdown valves. The slurry consisted of 25 percent (wt) unfiltered SRC product dissolved in anthracene oil. The test temperature was increased to 343°C (650°F) from a previous value of 149°C (300°F), and the driver gas was changed from argon to hydrogen. Changing the impingement angle in the erosion test apparatus to 20 deg resulted in a close correspondence of erosion values with those of letdown valve tests. The 20-deg angle impingement test was accordingly established for the evaluation of letdown valve materials. The erosion resistance of sixteen different specimen materials was evaluated under these more severe test conditions. A consolidated diamond powder product was found to be the most erosion-resistant material among the group and chemical vapor deposited (CVD) SiC was found to be the next most erosion resistant material. CVD SiC was selected for further evaluation on the basis of the excellent resistance to erosion exhibited by the bulk SiC particles in a reaction-sintered product. Other than in the cases of materials which erode by loss of softer binder material and pullout of larger more erosion resistant particles, no evidence was found to aid in understanding the mechanisms involved in the erosion of the hard, essentially single phase materials. No evidence of chipping, crack formation or other local spallation was found. Candidate pump materials were evaluated for resistance to erosion to a slurry consisting of minus 200 mesh coal suspended in creosote oil. The tests were performed at 93°C (200°F) at a flow velocity of 56 m/sec (185 fps) to simulate a typical feed pump condition and at a higher velocity of 114 m/sec (375 fps) to shorten test time. A total of 14 different candidate materials were evaluated at two impingement angles, 20 and 70 deg.

25648 (EPRI-AF—585) Solvent refined coal (SRC) process operation of solvent refined coal pilot plant at Wilsonville, Alabama. Annual report, January—December 1976. Lewis, H.E.; Weber, W.H.; Usnick, G.B.; Hollenack, W.R.; Hooks, H.W. (Catalytic, Inc., Wilsonville, Ala. (USA)). Nov 1977. Contract EX-76-C-01-2279. 251p. Dep. NTIS, PC A12/MF A01.

Operating conditions and results for the six-ton-per-day Solvent Refined Coal pilot plant at Wilsonville, Alabama, for the fourth quarter of 1976 are presented. Results for the entire year are summarized. The first objective was correlation of the results from Wilsonville with the 50-ton-per-day Ft. Lewis pilot plant operation. This correlation was established by processing Kentucky 9 and 14 coal. A second objective was to determine the effect of process variables on yield and quality when processing other coals. This was completed for Monterey (Ill. 6) and was continuing for Amax Belle Ayr coal. The effects on the operation of varying the boiling range of the process solvent and the dissolver volume are reported. Also reported are the effects of operating variables on the overall plant solvent inventory balance. Filtration results show that the filter cake from Amax Belle Ayr coal has a lower resistance, but is more compressible, than the filter cake from either the Kentucky 9 and 14 or the Monterey (Ill. 6) coals. Work with precoat materials that do not contain asbestos is described. Other improvements to the filtration system are discussed. Results from testing of alternate methods for mineral residue separation, such as centrifuges, hydroclones, are described. Background information is reported for installing a system for preliminary evaluation of an antisolvent method for improvement of the mineral residue separation systems. SRC containing less than 0.16 percent ash, 0.96 percent sulfur was produced from each coal processed. An SRC solidifier, which uses indirect cooling, was developed and the capacity of the machine has been defined. Several alternate methods of solidification were also investigated.

25649 (FE—1517-55) Coal liquefaction pilot plant, Cresap, West Virginia. Monthly technical progress report, September 1977. (Fluor Engineers and Constructors, Inc., Irvine, Calif. (USA)). Dec 1977. Contract EX-76-C-01-1517. 22p. Dep. NTIS, PC A02/MF A01.

All construction activities have been completed; the Fluor E and C field office has been closed; and all craft personnel have been terminated. Integrated hot solvent circulation was established among the Extraction (200), Solids Separation (300), and Solvent Recovery (500) sections of the pilot plant. Char combustion was established in Section 800, Low Temperature Carbonization. The front-end start-up was interrupted on different occasions to repair leaks which developed as normal operating temperatures were approached; to correct a high pressure drop in the Extraction Section; and for further repairs to the extractor shaft seals. The front-end should be ready to process coal by early next month; extract granulation will start shortly thereafter. Operability, using nitrogen, of one of the makeup hydrogen compressors in series with one of the recycle hydrogen compressors was demonstrated at 3000 psig. The pressure checking of Hydrogenation (600), has slowed due to the inability of many of the Conval valves to hold 600 psig nitrogen pressure. Temporary craftsmen are being added to meet this problem and speed winterization activities. Five current problem areas are discussed.

25650 (FE—1517-58) Coal liquefaction pilot plant, Cresap, West Virginia. Monthly technical progress report, November 1977. (Fluor Engineers and Constructors, Inc., Irvine, Calif. (USA)). Jan 1978. Contract EX-76-C-01-1517. 22p. Dep. NTIS, PC A02/MF A01.

It is apparent that the highest priorities have to be given to the tasks of starting up and operating the plant. Cresap is still regarded as a test facility. With the time and money that went into researching, designing, and installing the test equipment, DOE believes that a substantial amount of data will be obtained from the test program. However, instead of a highly sophisticated data gathering and reporting program, the bulk of the information will have to come from the maintenance records as well as the trained observations of LCDC personnel. Now that the resources required to start up and operate the plant are known, it is necessary to review tha remainder of the program to maximize the amount of test program data attainable within the funds now available to the project.

25651 (FE—1743-46) Zinc halide hydrocracking process for distillate fuels from coal. Monthly technical progress report, November 1977. (Conoco Coal Development Co., Library, Pa. (USA). Research Div.). 15 Dec 1977. Contract EX-76-C-01-1743. 13p. Dep. NTIS, PC A02/MF A01.

Construction of the 100 lb/hr PDU continued on schedule for completion of the liquefaction section in December. Pressure testing of the first section was completed. Completion of the Regeneration Section (and the plant) is now scheduled for April 30, 1978. The continuous bench-scale hydrocracker program has been completed. The results have been correlated by a first-order model which fits the data well. This correlation and yield correlations apply for Colstrip subbituminous coal liquefied at 385-413°C (725 to 775°F) and 13.8 to 20.6 MPa (2000 to 3000 psig) of hydrogen. The second attempt to dry and grind the subbituminous coal for PDU use reduced the oxygen level in the drying gases from 6% to 2.5%. The product will be tested in our autoclave for response to zinc chloride liquefaction. An economic study has been completed showing a saving of 3 cents/gallon gasoline if secondary recovery of zinc from effluent ash is used.

25652 (FE—2035-10) Enthalpy measurement of coal-derived liquids. Quarterly technical progress report, October—December 1977. Kidnay, A.J.; Yesavage, V.F. (Colorado School of Mines, Golden (USA). Dept. of Chemical and Petroleum Refining Engineering). 15 Jan 1978. Contract EX-76-C-01-2035. 20p. Dep. NTIS, PC A02/MF A01.

Experimental enthalpy measurements were made on a naphtha sample produced by the SRC-I process. A total of 116 enthalpy determinations were made covering the ranges 160 to 670°F and 30 to 900 psia. Additional measurements are needed, however, in the critical region. A comparison of three correlations for enthalpy with the experimental data for a Synthoil distillate (ninth quarterly progress report) was also made. The predicted enthalpies were considerably in error.

25653 (FE—2202-21) **Homogeneous catalytic hydrocracking processes for conversion of coal to liquid fuels: basic and exploratory research. Quarterly report No. 7, May 1, 1977—July 31, 1977.** (SRI International, Menlo Park, Calif. (USA)). 28 Sep 1977. Contract EX-76-C-01-2202. 61p. Dep. NTIS, PC A04/MF A01.

We have examined the coal conversion potential of the suspended heterogeneous catalyst system and homogeneous base catalysis. In the suspended catalyst experiment, the coal was converted in high yield to distillates (about 76%) and some gases (13%). The liquids appear to have relatively low heteroatom contents. We have screened pyridine, ammonia, and CaO for their effectiveness in catalyzing the upgrading of coal in methanol at 400°C (752°F). Pyridine and NH_3 were ineffective and were incorporated to a major degree, where CaO proved to be intermediate in effectiveness. Coal was used in a system at 400°C at a reaction time of almost 1 hr, which provided a higher yield of a lower viscosity liquid than at shorter reaction times, but let a solid that was poorer in hydrogen and much less pyridine-soluble. The model compounds biphenyl and phenanthrene proved stable under these MeOH/KOH conditions at 400°C, but anthracene was largely converted to 9,10-dihydroanthracene and phenyl ether was at least one-third converted to anisole and multiply methylated anisoles and phenols. We have also studied the effect of reaction time on the interaction of coal with phenol and a phenol-tetralin mixture. The interactions of coal with pyridine and a pyridine-Tetralin mixture were also studied. Pyridine was found to be a poor medium for coal conversion, yielding a product of between 10 and 12% pyridine solubility for reaction times up to 4 min at 400°C. Measurement of the rate of thermal cleavage of the benzylic bond and competitive secondary reactions in the pyrolysis of 1-ethylnaphthalene has continued.

25654 (FE—2244-15) **Flash pyrolysis coal liquefaction process development. Monthly report, July 1977.** Knell, E.W.; Gethard, P.E.; Shaw, B.W.; Green, N.W.; Willson, W.G. (Occidental Research Corp., La Verne, Calif. (USA)). 1977. Contract EX-76-C-01-2244. 14p. Dep. NTIS, PC A02/MF A01.

Extended operation with bituminous coal was limited by poor char circulation control. Modifications to the char circulation system to improve control will be tested next month. A series of short tests with the PDU suggest that product tar from subbituminous coal is adsorbed and cracked on the surface of the char. Tests have been scheduled on the BSR to further evaluate this premise. A concept to pneumatically lift char from a fluidized-bed reservoir was successfully tested in a preliminary cold flow apparatus. The char lift concept is potentially more stable than the mechanical method currently employed in the PDU.

25655 (FE—2260-16) **H-Coal Pilot Plant. Phase II. Construction. Phase III. Operation. Monthly report, December 1977.** (Ashland Synthetic Fuels, Inc., Ky. (USA)). 20 Jan 1978. Contract EX-76-C-01-2260. 153p. Dep. NTIS, PC A08/MF A01.

As of December 20, 1977, pilot plant construction of Sections 100, 200, and 400 is 39.1% complete, a 3.7% increase in construction progress for the four week reporting period. Of the eight other authorized subcontracts, three are complete, three are on schedule, and two are behind schedule due to adverse weather conditions. 99.6% of the 2,682 total drawings have been certified for construction. The pilot plant training manuals for Sections 100, 200 and 400 are 63% complete. Thirty-six of the total fifty-seven manuals have been written and are under various stages of final preparation. Several computer programs have been prepared for use in predicting pilot plant performance and as aids in analyzing pilot plant results. Analyses of Kentucky No. 11 Coal, supplied in December by Island Creek Coal Company, indicates that this coal supply for the pilot plant is very similar to the Burning Star Illinois No. 6 coal used in PDU runs 1 through 4. These analyses are presented.

25656 (FE—2307-25) **Research and development of rapid hydrogenation for coal conversion to synthetic motor fuels (riser cracking of coal). Second quarter report, July 1—September 30, 1977.** Duncan, D.A.; Beeson, J.L.; Oberle, R.D. (Institute of Gas Technology, Chicago, Ill. (USA)). Nov 1977. Contract EX-76-C-01-2307. 27p. Dep. NTIS, PC A03/MF A01.

The series of runs investigating the effects of reaction temperature and hydrogen-to-coal ratio using concurrent heating of coal and hydrogen was continued. Progress was handicapped by a coil failure (small split near the outlet end) and later by leaks in the sleeves used to connect coil sections. Seven runs were accomplished at 2000 psig with hydrogen concentrations of 33 and 50 weight percent. The temperature range was 1400 to 1500°F. The data obtained thus far indicate that the hydropyrolysis gasoline quality is very sensitive to coil outlet temperature and hydrogen partial pressure. Octane number was decreased by increases in both of these variables over the range studied.

25657 (FE—2335-13) **Catalyst development for coal liquefaction. Annual report, July 1, 1976—June 30, 1977.** Hindin, S.G. (Engelhard Minerals and Chemicals Corp., Edison, N.J. (USA). Engelhard Industries Div.). Oct 1977. Contract EX-76-C-01-2335. 191p. Dep. NTIS, PC A09/MF A01.

The goal of this program is the development of an improved catalyst for coal liquefaction. Initial catalyst screening was carried out, batchwise, in a stirred autoclave. Promising candidates will be further evaluated in a fixed-bed continuous reactor designed to simulate potential commercial operating conditions. Results generated from the first year's work on this program are reported. Catalyst supports, hydrothermally stable at coal liquefaction conditions, have been prepared with differing pore-size distributions and varying acidities to determine whether these parameters are critical in coal liquefaction and heteroatom removal. A technique has been developed to measure surface acidity by programmed desorption of adsorbed bases. An autoclave screening unit has been constructed and a test development program carried out to define the test conditions required for the evaluation of catalyst performance. Screening of experimental catalysts was initiated towards the end of the report period. The work-up procedure separates product into three fractions, benzene-soluble, pentane-insoluble and pentane-soluble. The fixed-bed trickle-phase reactor, operating downflow with high recycle of generated product, has been designed and built.

25658 (FE—2335-16) **Catalyst development for coal liquefaction. Interim report, July—September 1977.** Hindin, S.G. (Engelhard Minerals and Chemicals Corp., Murray Hill, N.J. (USA). Engelhard Industries Div.). Oct 1977. Contract EF-76-C-01-2335. 27p. Dep. NTIS, PC A03/MF A01.

No catalysts tested to date showed any advantage over the American Cyanamid 1442A catalyst, though a number showed equivalent performance. The relationship between liquefaction activity and catalyst acidity is still ambiguous and requires clarification. Aging of the American Cyanamid and Filtrol catalysts in a H_2O/H_2S atmosphere did not affect catalyst performance though it did markedly reduce their surface areas and sintered smaller diameter pores. This may mean that the level of CoMo can be sharply reduced with a stabilized alumina support. Gas make (as methane) is relatively constant and independent of both hydrogen consumption and coal conversion. If substantiated, this implies that hydrogen taken up in reaction is not consumed in light hydrocarbon production.

25659 (FE—2588-4) **Study of ebullated bed fluid dynamics for H-coal. Monthly progress report No. 4, December 1—December 31, 1977.** Vasalos, I.A.; Bild, E.M.; Evans, T.D.; Tatterson, D.F.; Vander Klay, A.P.; Wallin, C.C. (Amoco Oil Co., Naperville, Ill. (USA). Research and Development Dept.). Jan 1978. Contract EF-77-C-01-2588. 14p. Dep. NTIS, PC A02/MF A01.

The area of gas-liquid-solid fluidization has been of increasing research interest in recent years. Much of this research has been stimulated by industrial applications of ebullating bed reactors, such as the H-oil, H-coal, and Hy-C processes. A large volume of data on bed expansion over a wide range of flow conditions has been generated. This expansion data plus the information on various phase interactions have been the basis for several significant models which provide formats for correlating three-phase data. The importance of the corresponding liquid-solid and gas-liquid systems has been recognized by some of these models. Validation and modification of these models provide the best basis for future design and control of ebullating bed reactors. However, many of the studies have limitations: They were carried out in small-scale equipment, so wall effects may have dominated the flow situation to the point where only the slug flow regime could exist. In analyzing the data, many investigators did not recognize the importance of the corresponding two-phase systems of gas-liquid and liquid-solid. Many of these experiments need to be repeated using slurries, rather than liquids, to fluidize the bed. Emphasis on various aspects of design and construction of the cold flow unit continued. Detailed progress in each area includes the following: Systems Design—Recognizing that the most critical factor for completing the construction of the unit by May 1 is equipment availability, large effort was devoted to ordering equipment. Progress on equipment procurement is reported in Table I. Where possible, costs are also reported. Laboratory tests were also conducted to evaluate a flow meter (Micromotion) for measuring recycle slurry flow. Since studies by HRI have shown that up to 12 vol% gas may be contained in the recycle steam, these tests are necessary to establish the capability of this instrument with the presence of gas.

25660 (FE—2893-6) **EDS coal liquefaction process development, Phase III B. Monthly technical progress report, December 1—December 31, 1977.** (Exxon Research and Engineering Co., Florham Park, N.J. (USA)). Jan 1978. Contract EF-77-A-01-2893. 56p. Dep. NTIS, PC A04/MF A01.

The solvent quality study with Wyoming subbituminous coal in the 50 pound-per-day Recycle Coal Liquefaction Unit was completed. The study concentrated on investigation of the effects of increased solvent-to-coal ratio and liquefaction residence time. The liquefaction yield structure used for the updated commercial study design was finalized based on the latest runs at the Coal Liquefaction

Pilot Plant. Earlier results, which indicated higher start-of-run temperatures were required for a heavier feedstock to reach the same solvent donatable hydrogen level as for Multi-Pass Spent Solvent (MPSS), were confirmed. A process variable screening study utilizing Ni/Mo-10 and Ci/Mo-20 catalysts and Wyoming spent solvent was completed on the solvent hydrogenation two-train catalyst testing unit. The variables investigated were start-of-run temperatures and space velocities. The total 400+ °F coal liquid product produced from Illinois No. 6 coal burned with less smoke and lower particulate emissions than a petroleum reference fuel in a 50 horsepower Cleaver Brooks boiler combustion test. Data and operations of the Integrated Coking/Gasification Pilot Plant (IKG) were analyzed. An investment estimating basis for a commercial size unit was completed as part of the FLEXICOKING prototype cost/benefit study. The Baytown FLEXICOKING prototype screening study determined that a gasification level of at least 70% can be achieved for full feed ECLP vacuum bottoms rate of about 100 T/D for Illinois coal. A gasification level of 80% can be achieved at a feed rate of about 90 T/D. Plot plans for the Hydrogenation and Fuel Gas Treating areas were completed.

25661 (FE/1216—2) **Assessment of technology for the liquefaction of coal: summary.** (National Academy of Sciences - National Research Council, Washington, D.C. (USA)). Dec 1977. Contract EX-76-C-01-1216. 45p. Dep. NTIS, PC A03/MF A01.

Scale-up of the most promising solvent extraction process (Exxon) and the most promising direct catalytic coal-oil-slurry hydrogenation process (H-Coal) should be carried forward expeditiously at a scale of 250 to 600 tons per day. The construction of demonstration plants for other liquefaction processes should not be considered until small scale and pilot plant results have demonstrated substantial advantages over the Exxon and H-Coal processes. A vigorous effort should be made to reduce the size of the equipment for process development. As much work as possible should be carried out on the bench scale. Pilot plants should not be larger than 1 to 5 tons per day. Process demonstration should be carried out on units not larger than 250 to 600 tons per day. Solid separation techniques including improved filtration, distillation, and solvent precipitation should be vigorously investigated to identify the best approach. Besides these three, there are 7 other recommendations and 17 conclusions on which the recommendations are based.

25662 (ORNL/MIT—257) **Three-phase flow characteristics of cylindrical vessels.** Barreto, F.; Anderson, S.J.; Goldstein, B.R.; Moor, S.S. (Massachusetts Inst. of Tech., Oak Ridge, Tenn. (USA). School of Chemical Engineering Practice). 23 Sep 1977. Contract W-7405-ENG-26. 19p. Dep. NTIS, PC A02/MF A01.

The hydrodynamics of vertical, cocurrent upflow of air and coal slurries of water and glycerol in cylindrical vessels were studied. Runs were made using an empty 1.27-cm-ID x 2.5-m-long column and a 2.54-cm-ID x 1.6-m-long column packed with 0.32 cm x 0.32 cm cylindrical pellets. The slurry flow rates varied 8 to 18 and 14 to 80 cm^3/sec for packed and unpacked vessels, respectively. The gas flow rates ranged from 10 to 300 cm^3/sec for both cases. The viscosity of the coal slurry varied from 6.5 to 26 cp by increasing its glycerine content. Residence time distribution curves were obtained by using KCl impulses and by monitoring the electrical conductivities of the slurry at the inlet and exit of the column. Using one-dimensional dispersed plug flow model, axial dispersion coefficients and liquid holdups were then calculated. For an empty column, the axial dispersion coefficients increased when the slurry flow rates and slurry viscosities increased. Increasing the slurry flow rates and decreasing the gas flow rates caused liquid holdups to increase slightly. For a packed column, axial dispersion coefficients increased with increasing slurry velocities but showed no apparent variation when changing gas flow rates or slurry viscosities. Energy dissipation increased with increasing slurry flow rates, slurry viscosities, and gas flow rates.

25663 (SAND—77-1558C) **Effects of mineral matter on the hydroliquefaction of coal.** Granoff, B.; Thomas, M.G.; Baca, P.M.; Noles, G.T. (Sandia Labs., Albuquerque, N.Mex. (USA)). 1978. Contract EY-76-C-04-0789. 7p. (CONF-780305—8). Dep. NTIS, PC A02/MF A01.

From Division of fuel chemistry meeting; Anaheim, CA, USA (12 Mar 1978).

Batch autoclave experiments have been carried out with Illinois No. 6 coal (Orient 4 Mine) in creosote oil. Various minerals, a dry liquefaction residue and a Co/Mo catalyst were added to the feed coal, while all process parameters (pressure, temperature, residence time, heating rate and solvent-to-coal ratio) were held constant. Significant increases in conversion to benzene solubles were observed when pyrrhotite (FeS), residue and Co/Mo had been used. Decreases in the viscosity of the liquid products were found in the spiking runs with pyrite, pyrrhotite and Co/Mo. The largest decrease in viscosity occurred in the experiment with Co/Mo and, in this case, a concomitant decrease in the organic benzene insolubles was found. A selectivity was observed in which pyrite affected only the asphaltene content of the liquid product, but pyrrhotite affected both the asphaltenes and the organic benzene insolubles. The data have shown that pyrrhotite and Co/Mo were active for desulfurization, but pyrite and most of the other minerals were not. Hydrogen consumption, as estimated from differences in the venting pressure, increased in all spiking experiments - especially when Co/Mo had been added to the feed. The H/C ratios of the liquid products, however, were similar. This would imply that hydrogen had been utilized primarily for heteroatom removal, conversion to benzene solubles and hydrocarbon gas formation.

25664 (SAND—77-1560C) **Hydrogen consumption in non-catalyzed coal liquefaction.** Thomas, M.G.; Granoff, B.; Noles, G.T.; Baca, P.M. (Sandia Labs., Albuquerque, N.Mex. (USA)). 1978. Contract EY-76-C-04-0789. 8p. (CONF-780305—2). NTIS, MF A01.

From Division of fuel chemistry meeting; Anaheim, CA, USA (12 Mar 1978).

Portions of document are illegible.

This discussion has considered liquefaction as two competing reactions; one which produces solubilized defunctionalized products, and a pyrolysis reaction which consumes hydrogen. Responses of the reactions to the independent variables of pressure, temperature, and time have been described and suggest that hydrogen pressure and time favor the liquefaction reactions (decreases in C/H ratio, decreases in sulfur, and increases in conversion), but that temperature seems to preferentially favor pyrolysis. These conclusions are in general agreement with literature data. Additionally it has been shown that (1) sulfur removal occurs concurrent with conversions among the various solvent extraction fractions, (2) conversion varies with H_2 consumption among a number of similar but different coals and (3) hydrogen consumption must be evaluated on the basis of a total balance, not just a change in concentration of H_2 gas.

25665 (TID—28167) **Clean solid and liquid fuels from coal. Quarterly progress report, July—September 1977.** Gary, J.H.; Golden, J.O.; Baldwin, R.; Bain, R.L.; Dickerhoof, D.W. (Colorado School of Mines, Golden (USA)). 1977. Contract EX-76-C-01-2047. 88p. Dep. NTIS, PC A05/MF A01.

All safety modifications to the continuous processing units were completed. Considerable difficulty was experienced in operation of the manual remote sampling system, but the problems were overcome by re-assembly of the vendor-supplied air-operated valves. Extensive testing demonstrated reliable operation. The first continuous processing run (6 hour duration) in a stirred tank mode was successfully made. Two isotherms (360°C and 390°C) were completed on the CO-Steam inexpensive catalyst study, using a mixture of Fe_2O_3 and Na_2CO_3 as the shift reaction catalyst. Runs at four different time levels were made at both temperatures to obtain kinetic information on conversion and heteroatom removal rates. The liquefaction kinetics study was completed, and the data successfully modeled using a non-linear parameter estimation program. Rate constants for the six series-parallel reactions in the mechanism were determined and activation energies calculated for each step. Evaluation of seven commercial hydrogenation catalysts was completed in the trickle bed reactor. Recycle oil from the Fort Lewis SRC plant was used as the feed, and HDS and HDN activity over an eight-hour run time was evaluated for each of the catalysts plus one blank. Work on subclassification of compounds present in coal liquids continued. Extensive mass spec data on a nitrogen-rich fraction from an ion exchange column at CSM was received from the Grand Forks Energy Research Center. Further liquid chromatography on nitrogen compounds in liquids proceeded.

PYROLYSIS AND CRACKING

REFER ALSO TO CITATION(S) 25619

SOLVENT EXTRACTION

REFER ALSO TO CITATION(S) 25653

BY-PRODUCTS

REFER ALSO TO CITATION(S) 25633, 25670, 25673, 25674

25666 **Effect of carbon deposition on porosity and reactivity of a lignite char.** Kamishita, M.; Mahajan, O.P.; Walker, P.L. Jr. (Pa State Univ, University Park). *Fuel;* **56**: No. 4, 444-450(Oct 1977).

This paper describes the effect of carbon deposition within the pore volume of a lignite char on changes in the porosity during gasification. Carbon deposition from the cracking of methane into the pores of a lignite char occurs at a significant rate at temperatures between 815 and 855$degree$C. Removal of the inorganic impurities from the char by acid washing significantly reduces the extent of carbon deposition. Carbon deposition reduces surface area and open pore volume of the char and accessibility of methane into the pore structure. Deposition of carbon has a large and lasting adverse effect

on the subsequent reactivity of the char to air. Results indicate that in order to maximize subsequent char reactivity to oxidizing gases, carbon deposition from volatiles during the conversion of coal to char should be kept to a minimum. 16 refs.

PROPERTIES

REFER ALSO TO CITATION(S) 25617, 25652, 25666, 25685, 25706, 25707, 26130

25667 (PERC/RI—77/14) **Spectral studies of coal-derived liquids.** (Department of Energy, Pittsburgh, Pa. (USA). Pittsburgh Energy Research Center). Nov 1977. 80p. Dep. NTIS, PC A05/MF A01.

Coal-derived materials from the PERC/ERDA SYNTHOIL process have been studied with an array of spectrometric techniques. Spectral measurements are reported for the process feed coal, the total centrifuged liquid product (CLP) and 13 fractions derived from the CLP. Mass spectrometry, magnetic resonance and infrared spectroscopy were the primary instrumental techniques utilized.

25668 Prospects for carbon-13 nuclear magnetic resonance analysis of solid fossil-fuel materials. Bartuska, V.J.; Maciel, G.E.; Schaefer, J.; Stejskal, E.O. (Colo State Univ, Fort Collins). *Fuel;* **56**: No. 4, 354-358(Oct 1977).

The application of the techniques of dipolar decoupling, cross polarization and magic-angle spinning to analysis of anthracite, lignite and algal coal samples, and to oil shale and kerogen samples, are discussed. It is shown that cross-polarization spectra obtained with dipolar decoupling display chemical shift anisotropy which interferes with attempts to distinguish the resonances of aromatic and aliphatic carbons. However, with magic-angle spinning the distinction can be made. Propsects and potential difficulties with applications of these techniques are discussed. 13 refs.

25669 Origin of certain heterocyclic compounds from depolymerization of lignite. Franz, J.A.; Morrey, J.R.; Tingey, G.L.; Skiens, W.E.; Pugmire, R.J.; Grant, D.M. (Battelle Mem Inst, Richland, Wash). *Fuel;* **56**: No. 4, 366-368(Oct 1977).

The origins of products observed in the acid-catalysed phenolic depolymerization of a lignite are discussed. Methylene, methine-, and ethylene-bridged aromatic products were identified by gas chromatography--mass spectrometry (GCMS) techniques, demonstrating a close similarity to products from the depolymerization of brown coals and lignites. Reactions of model triarylmethane compounds under depolymerization conditions demonstrated the facile conversion of triarylmethine structures to diarylmethane structures. 10 refs.

25670 New method for sulphur concentration measurements in coal and char. Solomon, P.R.; Manzione, A.V. (United Technol Res Cent, East Hartford, Conn). *Fuel;* **56**: No. 4, 393-396(Oct 1977).

A new method has been developed for determining the organic sulphur concentration and the stoichiometry of iron sulphide compounds in coals and chars. The method employs a scanning electron microprobe which separates the contribution from different sulphur forms by examining the differences in their spatial distribution. The method is rapid, requires only small samples, and is nondestructive; so results may be repeated. 4 refs.

25671 Moessbauer spectroscopy of iron compounds found in West Virginia coals. Montano, P.A. (WVa Univ, Morgantown). *Fuel;* **56**: No. 4, 397-400(Oct 1977).

Moessbauer measurements were carried out in several coal samples from various seams in West Virginia. The presence of iron pyrite and iron (II) sulphate was observed in all the samples studied. The two different mineral compounds were clearly identified from their isomer shift and quadrupole splitting, and the Moessbauer spectral area was used to determine their amounts. This method is recommended as a complementary technique for the measurement of the amount of sulphur bonded to iron in coals. 16 refs.

25672 Effect of cleavage of ether linkages on physicochemical properties of coals. Wachowska, H.; Pawlak, W. (A. Mickiewicz Univ, Poznan, Pol). *Fuel;* **56**: No. 4, 422-426(Oct 1977).

Coals of different rank were treated with naphthalene anion in tetrahydrofuran. It was found that, as in the case of coal of 87.8% C (daf), large amounts of unreactive oxygen bonds, possibly of the ether type, were cleaved. Cleavage of these ether linkages led to a lowering of the melting point and, in some types of coals, to a large increase in dilatation and a substantial increase in Gieseler fluidity. 12 refs.

25673 Composition and variation of pulverized fuel ash obtained from the combustion of sub-bituminous coals, New Zealand. Bibby, D.M. (Dep of Sci and Ind Res, Petone, NZ). *Fuel;* **56**: No. 4, 427-431(Oct 1977).

Twenty daily samples of pulverized fuel ash (PFA), obtained from the combustion of sub-bituminous Waikato coals, have been analysed. The contents of MgO, SO$sub 3$, B$sub 2$O$sub 3$ and total and uncombined CaO in the New Zealand material were high when compared with most PFA produced in Europe and the USA. The PFA was separated into three major components, namely a magnetic fraction, and nonmagnetic acid-insoluble and acid-soluble fractions. These three fractions were related to three major mineral suites found in the coal: respectively hydrated iron carbonates and oxides, quartz and aluminosilicates, and calcium minerals. A low-density fraction was separated and found to be similar in composition to cenospheres found in British and American PFA. 14 refs.

25674 Electrical conductivity of coal and coal char. Duba, A.G. (Univ of Calif, Lawrence Livermore Lab). *Fuel;* **56**: No. 4, 441-443(Oct 1977).

The electrical conductivity of coal, at either 1 kHz or d.c., was measured at 24°C on samples recovered from pyrolysis experiments aimed at modelling conditions during in situ gasification of coal. Capitalizing on the large contrast between the conductivities of coal and char produced during gasification, electrical probing may be a sensitive tool for monitoring 'burn-front' progress during in situ coal gasification. 15 refs.

25675 Study of the slagging properties of Kuznetsk coal ash. Alekhnovich, A.N.; Bogomolov, V.V.; Novitskii, N.V.; Ivanova, N.I. *Sov. Power Eng. (Engl. Transl.);* **6**: No. 9, 509-513(Sep 1977). Translated from Elektr. Stn.; 6: No. 9, 22-24(Sep 1977).

Slag problems in burning some Kuznetsk coals in certain types of boilers are discussed. The beginning of slagging varies from about 975° to 1050°C according to the mine from which the coal came. A formula for the temperature of the beginning of slagging is given using chemical composition data (Na_2O, K_2O, CaO, Fe_2O_3), but the correlation on which it is based does not seem to be very good. Certain observations with respect to boiler deposits are discussed. Primary deposits have a loose structure without appreciable strength, but these can become enriched with secondary deposits, which then sinter to make relatively strong deposits. Apparently, the temperature of the gas and of the surface both affect the nature of the slagging. Three types of slagging are discussed depending on gas temperature, surface temperature and the source of the coal. (LTN)

25676 Aftergases of coal dust explosions generated in an experimental chamber. Ishihama, W.; Enomoto, H.; Yamao, S. *Nippon Kogyo Kaishi;* **93**: No. 1073, 483-488(Jul 1977). (In Japanese).

Characteristics of aftergases for three high-volatile bituminous coals were investigated using a closed-type experimental apparatus. The aftergas was chemically analyzed for H_2, Co, Ch_4, and other hydrocarbons; tars were not analyzed. The data show that these gases have peak concentrations near the optimum dust concentration at which the explosion pressure is highest. Among these gases, CO is the most concentrated with a maximum value of about 8%; the concentration of hydrocarbons, except CH_4, is less than 1%. A computer calculation confirmed that air-aftergas mixtures were highly explosive. 9 refs.

WASTE MANAGEMENT

REFER ALSO TO CITATION(S) 26130, 26196

25677 (EPRI-AF—560) **Panel bed filter. Final report.** Lee, K.C.; Rodon, I.; Wu, M.S.; Pfeffer, R.; Squires, A.M. (City Coll., New York (USA). Dept. of Chemical Engineering). May 1977. 415p. Dep. NTIS, PC A18/MF A01.

Studies were undertaken to test the filtration performance of the panel bed filter at 300°F in a laboratory unit; to test puffback cleaning of the filter in a tall panel representing a single element of a commercial design; to study the filtration performance of a coherent surface deposit of fly ash resting upon sand or other granular solid; and to develop mathematical models for application of the panel bed filter as a gas-solid reactor or heat-exchanger. In laboratory tests with redispersed power-station fly ash, the panel bed affords high filtration efficiencies (beyond 99.95% removal of fly ash) at 300°F with practicable gas throughput and pressure drop. The ground area occupied by a commercial filter ought to be less than one-half that required for an electrostatic precipitator of high efficiency, and the pressure drop can be on the order of six inches of water. Efficiency in these tests for removal of sub-micron particles is estimated at beyond 99%. This estimate is supported by separate experiments studying filtration of a monodisperse aerosol of 1.1-micron particles by a fly ash deposit resting upon a sand bed. Puffback cleaning of the tall panel, using a commercially-available valve, was successful. Mathematical modeling of the panel bed suggests its applicability for conducting gas-solid reactions or heat exchange. In some applications of this type (such as the removal of hydrogen sulfide from a fuel gas at high pressure), the required flow of reactive solid is so great in comparison with the quantity of granular solid needed to

filter dust from the gas that it will be advantageous to use a panel bed with additional columns of louvers supporting a continuously gravitating bed of reactive solid supplied at the top and withdrawn at the bottom.

25678 (EPRI-FP—595) **Application of scrubbing systems to low sulfur/alkaline ash coals. Final report.** LaMantia, C.R.; Lunt, R.R.; Jashnani, I.L.; Donnelly, R.G.; Interess, E.; Woodland, L.R.; Adams, M.E. (Little (Arthur D.), Inc., Cambridge, Mass. (USA)). Dec 1977. 383p. Dep. NTIS, PC A17/MF A01.

The objectives of this study were to collect and evaluate available information on low sulfur Western coals which produce alkaline fly ash and on the behavior of such fly ash in scrubbing systems; and to determine whether sufficient data are available to develop guidelines and specifications for future scrubbing systems based upon fuel and ash analyses and boiler design information. Data from five pilot plant operations and 19 full-scale operating systems (about 4,100 Mw of boiler generating capacity fired with low sulfur Western coals) were reviewed and summarized. Data analysis performed as part of the study concentrated on unique aspects of alkaline fly ash scrubbing systems, i.e., the behavior of alkaline fly ash in scrubbing systems and approaches to predicting ash behavior based upon fuel and ash characteristics. Scrubbing system performance characteristics investigated include the following: particulate removal; SO_2 removal; ash alkali and supplementary alkali utilization; oxidation; scaling; water balance; waste properties; and performance of materials. Additional data and procedures are required in the following areas in order to predict scrubbing system performance: ash reactivity and alkalinity (prediction of these properties without pilot plant operations); waste solids (chemical and physical properties); and the performance of materials of construction in scrubbing service with particular emphasis on plastic linings.

25679 (EPRI-FP—639) **Summary of the effects of important chemical variables upon the performance of lime/limestone wet scrubbing systems. Interim report.** Corbett, W.E.; Hargrove, O.W.; Merrill, R.S. (Radian Corp., Austin, Tex. (USA)). Dec 1977. 55p. Dep. NTIS, PC A04/MF A01.

This document is written to provide both current and prospective operators of lime/limestone wet scrubbing systems with a general summary of the important chemical variables and their effects upon the performance of these systems. This discussion is based upon information derived from three primary sources: (1) the open literature, (2) contacts with scrubbing system operators, and (3) Radian experience. Three separate but related areas are discussed: (1) scrubber performance, which includes both SO_2 removal and additive selection and utilization considerations, (2) techniques for precipitating calcium- and sulfur-containing solids in a scale free manner, and (3) factors relating to the quality of the product sludge and its disposal. It is concluded that although lime/limestone scrubbing systems tend to be somewhat simple mechanically, they are very complex from a chemical process point of view. And, although many important variable effects and interactions have been documented, considerable gaps in our understanding of the chemistry of these systems still exist.

25680 (EPRI-FP—671) **State-of-the-art of FGD sludge fixation. Final report.** Duvel, W.A. Jr.; Gallagher, W.R.; Knight, R.G.; Kolarz, C.R.; McLaren, R.J. (Baker (Michael), Jr., Inc., Beaver, Pa. (USA)). Jan 1978. 270p. Dep. NTIS, PC A12/MF A01.

Thirty-one fully operational flue gas cleaning electric utility lime/limestone and alkaline flyash wet scrubbing systems were evaluated to determine the practical significance of FGD sludge fixation. Five commercial sludge fixation installations are in operation. Other disposal practices are widespread and acceptable. Nine installations are landfilling wastes using various types of processing while seventeen are using ponding for dewatering and ultimate disposal. Of sixteen vendor companies evaluated, only two—IU Conversion Systems (IUCS) and Dravo Corporation—have demonstrated fully commercial capability. The other vendors have little or no FGD waste experience. Both IUCS and Dravo products exhibit lower permeability, greater strength, and overall improved physical, chemical, and engineering properties compared to untreated sludges. Dravo has one full-scale, 1650 Mw facility; IUCS has four installations totaling 1818 Mw. Estimated 30-year levelized incremental sludge fixation revenue requirements are $6.90 and $2.50 per dry ton of sludge solids for wet disposal (ponding) and dry disposal (landfilling), respectively. These costs are not highly site-dependent and can be applied generally. By-product recovery/utilization concepts were found to be technically feasible but not economically competitive at this time. The most promising concepts are utilization of fixed sludge as a construction material, production of by-product gypsum with utilization in agriculture and wallboard manufacturing, and mine reclamation.

25681 (FE—2408-5) **Study of the mechanism of the hydrogen sulfide/dolomite reaction. Quarterly report, July 1977—October 1977.** Li, K.; Rogan, F.H. (Carnegie-Mellon Univ., Pittsburgh, Pa. (USA)). Oct 1977. Contract EX-76-C-01-2408. 52p. Dep. NTIS, PC A04/MF A01.

Rate and structure data collection for the half-calcination and subsequent sulfidation of dolomite has continued on schedule. New results are reported for both sulfidation and calcination of 1337 dolomite, as well as the first rate data for calcination of 1341 dolomite. Studies of the carbonation reaction have not yet been initiated due to delayed construction of the water injection system. Carbonation experiments are scheduled to begin early next quarter. SEM studies of half-calcined dolomite have not been very informative, as the structural changes during calcination occur primarily at the sub-grain level. Optical microscopy of polished and stained sections, however, promises to be a useful analytical tool for both half-calcined and sulfided dolomite. Some difficulty was encountered with sulfur contamination of the experimental system, leading to blockages in the gas feed lines and casting doubt on the validity of some previous calcination rate data. This problem has been solved by using one reactor tube for half-calcination and another for sulfidation, and thoroughly purging the system at high temperature after each sulfidation experiment.

25682 (NP—23088) **Production of forty percent core area flyash brick using a lignite flyash, a northern West Virginia flyash, and a western Kentucky flyash. Report No. 112.** Slonaker, J.F. (West Virginia Univ., Morgantown (USA). Coal Research Bureau). Oct 1975. 16p. Virginia Univ., Morgantown.

The American Society for Testing and Materials (A.S.T.M.) is presently considering revisions to A.S.T.M. specifications for brick which will permit the use of coring up to 40 percent of the brick cross-sectional area in any plane parallel to the bearing surface. In flyash brick the reduced solid volume and thinner cross-sectional area will result in a lighter unit weight and should also result in improved thermal insulating properties which are a vital consideration in view of the current energy shortage. In flyash brick the reduced solid volume and thinner cross-sectional area also affects the sodium silicate requirements and other variables in the batch composition. This report discusses the results obtained by varying the sodium silicate content and other variables in 40 percent core area flyash brick made using flyash from three different sources.

25683 (NP—23089) **Study of the effect of firing conditions upon flyash structural products. Report No. 128.** Slonaker, J.F. (West Virginia Univ., Morgantown (USA). Coal Research Bureau). Nov 1976. 17p. Virginia Univ., Morgantown.

This study shows that there is a different firing range for each flyash and each flyash has an optimum firing temperature. By obtaining and utilizing data which presents the effect of firing conditions upon flyash structural products it is possible to select a firing temperature which will minimize energy consumption while producing a superior quality product.

25684 (PB—273812) **Emission testing and evaluation of Ford/Koppers coke pushing control system. Volume I. Final report. Report for Dec 73—Aug 77.** Cooper, F.; Loch, T.; Mutchler, J.; Vecchio, J. (Ford Motor Co., Dearborn, Mich. (USA)). Sep 1977. Contract EPA-68-02-0630. 278p. NTIS PC A13/MF A01.

The report documents a field testing and engineering evaluation of the performance of a retrofitted, mobile-hood, high-energy-scrubber control system, abating coke-side pushing emissions from a 58-oven coke battery. It documents the venturi-scrubber inlet and outlet emission rates, as well as emission factors for filterable and condensible particulate, sulfur dioxide, sulfur trioxide, total sulfur oxides, carbon monoxide, nitrogen oxides, benzene, benzene and homologues, total light hydrocarbons, methane and homologues, and ethylene and homologues. Results indicate that the mobile hood collects particulate emissions resulting from green and clean pushes at 22% to 54% efficiencies, respectively, or from 30% to 92%, respectively, using two different estimating techniques. Scrubber performance averaged 99.3% for particulate emissions captured in the hood.

25685 **Carbon analysis in fly ash.** Pecora, L.M.; Srikrishnan, V.; Aldrich, R.G.; Ficalora, P.J. (Syracuse Univ, NY). *Fuel;* **56**: No. 4, 414-416(Oct 1977).

A combination of established experimental techniques, i.e. fluorine combustion and mass spectrometry, is presented as a method for the rapid determination of the carbon content in fly ash. Fluorine combustion of fly ash and subsequent gas analysis is shown to agree well with standard loss on ignition analysis for carbon in various fly ashes. Extension of the technique to other elements which form volatile fluorides is mentioned. 3 refs.

ENVIRONMENTAL ASPECTS

REFER ALSO TO CITATION(S) 25636, 25637, 25717, 26868, 26871, 26918, 26919, 26921, 26932, 26947

25686 (PB—269945) **Coal surface mining reclamation costs in the western United States. Information circular.** Persse, F.H.; Lockard, D.W.; Lindquist, A.E. (Bureau of Mines, Washington, D.C. (USA)). 1977. 40p. (BM-IC—8737). NTIS PC A03/MF A01.

The Bureau of Mines estimated reclamation costs for 13 surface coal mines in 9 states west of the Mississippi River. With the exception of the Pacific Coast coal province, at least one mine in each of the western coal provinces was studied. Cost estimates were made using standard estimating procedures from data obtained from company records, interviews with industry personnel, and onsite observations. Estimated costs are presentd in four categories which represent the four phases of mined-land reclamation: (1) Design, engineering, and overhead; (2) bond and permit fees; (3) backfilling and grading; and (4) revegetation. Estimated costs as of the first quarter of 1976 are expressed as averages and ranges in terms of per acre, per ton of coal produced, and per million Btu.

RESERVES AND EXPLORATION

REFER ALSO TO CITATION(S) 25729

25687 **Geology of the Coal Basin area, Pitkin County, Colorado.** Collins, B.A. pp 363-378 of Exploration frontiers of the central and southern Rockies. Veal, H.K. (ed.). Denver; Rocky Mountain Association of Geologists (1977).

From Symposium program RMAG fall field conference; Snowmass, CO, USA (29 Sep 1977).

See CONF-770972—.

Coal Basin is a large, deeply eroded anticlinal structure located in western Pitkin County, Colorado. The anticline was formed by doming of sediments over a small laccolithic intrusive. A variety of fault types and dikes, sills, and small plugs resulted from the intrusion. The Upper Cretaceous of the Coal Basin area consists of the Mancos Shale, the Iles Formation, and the Williams Fork Formation, the latter two making up the Mesaverde Group. The Mesaverde Group was deposited by a south-southeastward prograding deltaic complex. Three cycles of marine shale, delta-front sand, and lower deltaic plain sediments, including economic coal beds, are present in the area. This intertonguing was caused by compaction and shifting centers of deposition, and possibly by penecontemporaneous deformation, including growth faulting. The coals of the Coal Basin area were deposited generally in fresh-water swamps, and are made up primarily of the remains of woody plants. Heat from the igneous intrusion which produced the fold increased the rank of the coal substantially from that normally found in unintruded areas of the Piceance basin. Approximately 1 million tons of high-grade metallurgical coal is now being produced annually from coal beds in the Williams Fork Formatiion in Coal Basin.

25688 **Coal and methane gas in the southeastern part of the Piceance Creek basin, Colorado.** Murray, D.K.; Fender, H.B.; Jones, D.C. (Colorado Geological Survey, Denver). pp 379-405 of Exploration frontiers of the central and southern Rockies. Veal, H.K. (ed.). Denver; Rocky Mountain Association of Geologists (1977).

From Symposium program RMAG fall field conference; Snowmass, CO, USA (29 Sep 1977).

See CONF-770972—.

The southeastern part of the Laramide Piceance Creek basin is one of the most important coal-producing areas in the western U.S. This also is a region of accelerated exploration for natural gas. The Upper Cretaceous Mesaverde Group contains the major coal beds and gas-bearing sandstones found in this part of Colorado; these strata are part of a sequence of marine, transitional, non-marine sediments. These complex rock units are of possible deltaic and/or coastal plain origin and represent east-west oscillations of the Late Cretaceous seaway. Numerous Tertiary intrusive bodies and related structural complexities characterize the eastern part of the area investigated. Abnormally high heat flow resulting from this plutonic activity has raised the rank of much of the coal that occurs here. As a consequence, the region contains large resources of premium-grade coking coal, much of it existing under deep cover (greater than 1,000 ft) and often high in methane gas content. Most of the area's production consists of coking coal from underground mines. Several new mines of large capacity are in the planning or opening stages, which could result in an increase in the region's production of both coking and steam coal by a factor of two or three by 1980-1982. The large results of lower rank (high-volatile C bituminous) steam coal in the area offer an excellent potential for blending with high rank coals to form metallurgical coke. The region contains large resources of methane gas that should be commercially producible from both relatively "tight" sandstone reservoirs and from fractured coal beds by employing advanced technology now in the field demonstration stage. Work to date reveals that multiple, thick (+-20-50 ft) coal beds occur in the basin at depths exceeding 3,000-7,000 ft. This deep energy resource possibly could be exploited by the in-situ gasification of coal beds, whereby low-Btu gas is produced through boreholes.

MINING

REFER ALSO TO CITATION(S) 25686, 25721, 25724, 25725, 26921

25689 (BM-RI—8260) **Effects of hydraulic stimulation on coalbeds and associated strata.** Elder, C.H. (Bureau of Mines, Washington, D.C. (USA)). 1978. 20p. of Mines, Washington, DC.

In studies conducted by the Bureau of Mines, two test areas were hydraulically stimulated and exposed by mining: one in the Pittsburgh coalbed at the Vesta No. 5 mine, Washington County, Pa.; and one in the Illinois No. 6 coalbed at the Inland mine, Jefferson county, Ill. Induced fractures were contained totally within the coalbed with no adverse effect on the stability of associated rock strata. Induced fractures were vertical and were propagated normal to the direction of least residual tectonic stress. Gas production was increased fivefold to twentyfold by hydraulic stimulation. Periodic observations of exposed fractures produced by hydraulic stimulation have shown that no deterioration of roof and floor strata, or loss of coal rib stability occurred in the area of induced fractures. The mine entries observed remained structurally safe more than 2 years after mine interception of induced fractures.

25690 (BM-RI—8266) **Dry-process-sprayed coal mine sealants, an updated progress report.** Fraley, J.E. (Bureau of Mines, Washington, D.C. (USA)). 1978. 10p. of Mines, Washington, DC.

The Bureau of Mines has successfully developed and tested a machine for spraying sealant onto coal mine roof and ribs. Dry material is transported pneumatically to a water-adding nozzle designed to provide dust-free spraying while being nonplugging and self-cleaning. The machine is self-cleaning, 35 inches in height, and capable of applying $\frac{1}{2}$-inch-thick coatings at over 1,000 ft^2/hr.

25691 (BM-RI—8267) **Methane accumulations in coal mine roof cavities.** Vinson, R.P.; Thimons, E.D.; Kissell, F.N. (Bureau of Mines, Washington, D.C. (USA)). 1978. 19p. Dep. NTIS, PC A02/MF A01.

The Bureau of Mines investigated the presence and extent of methane accumulations in mine roof cavities using a full-scale mine model. Methane was released at a constant rate into the roof of a cavity built onto a 700-ft wind tunnel. Two box-shaped roof cavities were used in the study: one had a volume of 114.7 cu ft; and the other had a volume of 57.3 cu ft. Methane concentration was measured at 28 sampling points in the cavities using 21 different combinations of gas emission rates and air velocities. Brattice hung in the cavity helped reduce methane concentrations without auxiliary ventilation. It was also found that the effective ventilation rate increased by a factor of 40 in the large cavity and by a factor of 20 in the small cavity when air velocity was increased from 100 to 600 fpm.

25692 (PB—270024) **Limits and cost sensitivity of alternate parting handling methods. Volume I. Final summary report, December 1975—March 1977.** Finch, T.E.; Haley, D.R.; Speake, C.J. Jr. (Montana Coll. of Mineral Science and Technology, Butte (USA)). Mar 1977. 121p. NTIS PC A06/MF A01.

This report is a continuation and expansion of a previous Bureau of Mines grant (No. GO254004) which examined alternative methods of handling the parting between two coal seams in a surface mining operation. The alternative methods consist of equipment implementation in either a stowing or haulback technique. Following a typical strip mine conformation, the parting is directly stowed or hauled back and placed in the pit bottom after second seam removal. The objectives are to produce an environmentally sound material placement technique and to increase prime stripping machine utilization. This report contains the engineering philosophy behind two computer programs created to evaluate parting handling methods over a wide range of coal and parting thickness ratios. The nature of the computer approach allows cost sensitivity analysis and quick updating of costs. The two programs are clearly presented with documentation and examples so that consumers may apply them to their own operations.

25693 (PB—270189) **Underground mine communications. IV. Section-to-place communications. Information circular.** (Bureau of Mines, Pittsburgh, Pa. (USA). Pittsburgh Mining and Safety Research Center). 1977. 86p. NTIS PC A05/MF A01.

This is one of four volumes on underground mine communications; this volume focuses on equipment and methods to meet the special communications needs of key individuals in the working sections and places of coal and metal/nonmetal mines. Attention is also directed to recent developments in and future plans for locating and communicating with trapped miners.

25694 (PB—270696) **Longwall ignition suppression. Final report.** Rothchild, R.D.; Guzdar, A.R. (Foster-Miller Associates, Inc., Waltham, Mass. (USA)). Sep 1976. Contract J0357099. 146p. (BM—7511). NTIS PC A07/MF A01.

This report describes the results of a study of longwall ignition hazards and specific suppression systems to minimize each of the major hazards. The major ignition hazards were identified by conducting a literature search and conversing with knowledgeable individuals in the United States mining industry. Three classes of potential ignition suppression systems are discussed: triggered suppression systems for face ignition, passive suppression systems, and control of ignition hazard in the gob. The triggered suppression systems included protection for the shearer, head and tail gates, welding equipment, and the shearer power cable. Passive systems include improved ventilation and water sprays, and charges in the shearer head. Gob protection can be improved by isolating the gob from working areas and by introducting inerting agents into the gob.

25695 (PB—272699) **Mechanized longwall mining, a review emphasizing foreign technology. Information circular 1977.** Olson, J.J.; Tandanand, S. (Bureau of Mines, Twin Cities, Minn. (USA). Twin Cities Mining Research Center). 1977. 209p. (BM-IC—8740). NTIS PC A10/MF A01.

This report summarizes the results of a review of foreign coal mining literature conducted under the Bureau's Advancing Coal Mining Technology program. In addition to a discussion on the historical development of mechanized longwall systems, and the current state-of-the-art method in Europe, this report summarizes the previous and ongoing Bureau efforts to adapt longwall technology to U.S. conditions. The Bibliographic section of this report, divided into major categories such as mine design, face management, roadway development, strata control, powered roof supports, coal winning, conveying, and automation, contains over a thousand individual entries. The purpose of this report is to provide U.S. mining engineers with background information on longwall methodology and equipment developed in foreign countries (principally Europe). The Bureau of Mines is funding RandD projects to demonstrate that the longwall mining method, successfully used in the deep mines of Europe, can boost productivity and improve safety in certain U.S. mines.

25696 Studies on the flow characteristics of high speed water jets in air: the breakup characteristics of the water jet atomizer (2nd report). Yanaida, K.; Ohashi, A. *Nippon Kogyo Kaishi;* **93**: No. 1073, 489-494(Jul 1977). (In Japanese).

A theoretical analysis of the breakup characteristics of a water jet atomizer is presented. The analysis is experimentally verified using high-speed photography, an electric measuring device, and a laser velocimeter. On the basis of this investigation, the authors present a relationship between the characteristics of water jets in air and the hydraulic fracturing mechanism. The example of the effective jet length for hydraulic fracturing in coal mining is used. 12 refs.

25697 Criterion for gas, coal and rock bursts. Gil, H. *Przegl. Gorn.;* **33**: No. 6, 252-255(Jun 1977). (In Polish).

The burst is defined as a propagation of the fissure in the tensile stress field. The criterion links all basic parameters on which the burst depends. Bursts are closely connected with the state of stresses and gas pressure in the rock mass. The gas is a factor destroying the rock body and entraining the grains of the material. The horizontal component of the primary stress in the rock body reduces the strength of the seam. In the ribside zone tensile stresses occur which bring about the complete loss of ribside stability and a violent course of cracking which, in turn, explains the macroscopic mechanism of the outburst. 11 refs.

25698 Investigations on effect of protecting pillars on coal and gas burst prevention in Ostrava-Karvina district coal mines. Smid, M. *Przegl. Gorn.;* **33**: No. 6, 255-261(Jun 1977). (In Polish).

Early working of the protecting seam is considered as the most advantageous burst prevention measure. Parameters of burst hazards and of strains are determined in overmined and undermined seams to find a basis for a unified procedure in the delineation of angles and contours affecting the range of protection. 3 refs.

25699 Investigation of effects of concussion blasting combined with drilling destressing boreholes in roadsides, on the reduction of gas and rock bursts hazards. Kozlowski, B.; Siarkiewicz, R. *Przegl. Gorn.;* **33**: No. 6, 1-5(Jun 1977). (In Polish).

A new method developed in an experimental mine for drilling outgassing boreholes, is presented. Firing the charges of explosives in four concussion boreholes 6 m long with 42 mm dia. involving destressing of the solid coal ahead of the face. Additional destressing of raodsides was done by drilling small-diameter outgassing boreholes when gas pressure was still high after blasting. 2 refs.

25700 Method of operating a constant depth linear cutting head on a retrofitted continuous mining machine. Roepke, W.W.; Strebig, K.C.; Johnson, B.V. US Patent 4,025,116. 24 May 1977. Filed date 14 Aug 1975. 7p.

The patent relates to a method of operating a machine having a constant depth linear cutting head which is retrofitted to a continuous mining machine replacing the rotary head. By altering the usual configuration of the cutting head from the high speed rotating type with a large number of bits, as is currently being used, to one employing a non-rotary type head with 10 percent or less of the usual number of bits, and also operating a combined sumping and shearing action without the bits exiting the coal face being cut, less respirable dust is produced at the mine face. In addition to decreasing the dust and amount of menthane gas - when coal is mined - which is liberated, our method also produces more coal on the average for each cut in the mine face by deeper constant depth cuts in the 3- to 6-inch range by first sumping into the mine face and then shearing the face, without withdrawing or rotating the point attack bits.

25701 Linear cutting rotary head continuous mining machine. Roepke, W.W.; Lindroth, D.P.; Rasmussen, J.W. US Patent 4,012,077. 15 Mar 1977. Filed date 2 Jul 1976. 7p.

The patent relates to a triangular-shaped rotary head mounted on an eccentrically driven shaft which rotates at a low speed in a path determined by a ring/pinion gear ratio. Cutting tools mounted on the apices of the triangular-shaped rotary head follow a square path entering the face of the coal seam to be cut at a top corner and making a long linear vertical cut at a constant depth of approximately one and one-half times the diameter of the rotary head. This results in greatly reducing dust generation and methane ignition potential, while increasing productivity.

25702 Permeability from single and multiple detonations in boreholes. McKee, C.R. (Univ. of Wyoming, Laramie); Hanson, M.E.; Terhune, R.W. *In Situ;* **1**: No. 1, 37-73(1977).

Relationships describing the permeability enhancement caused by explosive detonations in boreholes have been derived and combined to yield k = k/sub c/[r/sup -3f-3//sub d//(r/sup -f-m//sub d/ + n/sub o//n/sub c/)^2] + k/sub o/, for the case in which the stress decays asymptotically as a power law; k/sub c/ and n/sub c/ represent permeability and fracture density at the edge of the pulverized region near the cavity wall; f is a geometric attenuation factor; m is the dissipation due to real material effects; k/sub o/ is the original permeability, n/sub o/ the initial fracture density, and r/sub d/ the scaled radius. This relationship has been compared with available measurements from the American "Hardhat" nuclear shot, the French nuclear events in Hoggar granite, and a chemical explosive shot in coal near Kemmerer, Wyoming. Significant correlation between theory and experimental measurements is observed. A comparison between single and multiple detonations shows that permeability enhancement falls off steeply near the shot; however, enhancement can be considerable midway between two shots spaced 10 cavity radii apart. The degree to which enhancement can be significant depends on material properties and initial fracture density. Porosity distribution from the explosive is the dominant parameter in permeability enhancement.

25703 General considerations of the design of instruments for use in coal mines. Cooper, L.R. (Mining Research and Development Establishment, Burton-on-Trent, Eng.). pp 27-38 of Operation of instruments in adverse environments, 1976. Knight, J. (ed.). London; Institute of Physics (1977).

From Conference on the operation of instruments in adverse environments; London, UK (4 Oct 1976).

See CONF-7610120—.

The use of instruments in coal mines is subject to regulations for safety in methane gas, and as most often the standard required is that of intrinsic safety, this sets a number of problems in circuit design. Other properties of the coal mine environment, such as dust, humidity and temperature, also have an influence on the types of instruments which may be used. The combined effect of these factors frequently dictates that instruments must be specifically designed for use in coal mines, and that standard surface instruments cannot be used. This paper describes some modified and some purpose-designed instruments, and experience in their use.

25704 (LA-tr—78-6) **Movements of air flows in the working zones of excavators in open-pit mines.** Beresnevich, P.V.; Nikolin, G.Ya.; Fursa, I.V.; Borod'ko, V.Ya. Translated from *Fiz.-Tekh. Probl. Razrab. Polezn. Iskop.;* **10**: No. 4, 143-146(1974). 9p. Dep. NTIS, PC A02/MF A01.

In the practical operation of open-pit mines, knowledge of the nature of the movement of air flows on the ledges in the working areas of excavators and transport equipment is useful. Such data is required for calculating the dispersion of noxious impurities in working with equipment, for determining when it is safe to begin mining and loading operations after large-scale blasting, and for choosing locations for the ventilation equipment used in the open-pit mine, etc. For these reasons, a series of industrial and laboratory studies were made on the quantitative evaluation of the process by

which airstreams flow around the working faces of excavators. Industrial studies of flow around the working faces of excavators were carried out by measuring the velocities and directions of air flows from the side of the working face or onto it, in the region of the working area of the ledge. It was established that when the air flows from the side of the working face, a recirculation zone comes into existence around the excavator in which the velocities of the air flows is decreased by 30 to 50% and more. The length of the recirculation zone at the bottom of the ledge reaches 3 to 4 times the height of the ledge. Mining and transport equipment in the area of the working face has a definite influence on the distribution of air flow velocities.

25705 (UCRL-Trans—11318) **Underground investigation of the hydraulic fracture zone along the iota; seam at the Lisichansk Podzemgaz Station.** Tyutin, F.G. Translated from *Podzemn. Gazif. Uglei;* No. 4, 22-25(1959). 15p. Dep. NTIS, PC A02/MF A01.

Portions of document are illegible.

The spatial position, dimensions, and sand filler distribution of fracture fissures formed in a coal seam were investigated. It was found that the paths of fracture fissures formed only in the bedding plane along interlayer contacts. Fracture occurred at the points of least resistance from contacts surrounded by less strong rocks and coal. To avoid undesirable fracture along the rocks, the bottom hole and borehole casing must be carried to a level somewhat above the boundary of the coal seam floor. In order for fracture to occur precisely along the coal seam, gases should be used as a coal strength reducer. The phenomenon of the failure of coal and rocks and their efflux from the fracture fissure lead to relief of the stressed state in the medium surrounding the fissure. This precludes the use of sand as a filler for stabilization of fissures. (JRD)

TRANSPORT AND HANDLING

25706 (BM-RI—8269) **Methane emissions from gassy coals in storage silos.** Matta, J.E.; LaScola, J.C.; Kissell, F.N. (Bureau of Mines, Washington, D.C. (USA)). 1978. 18p. Dep. NTIS, PC A02/MF A01.

The methane gas emitted from coal samples collected from conveyor belts dumping into silos was measured by the Bureau of Mines. Approximately 50 percent of the total gas desorbed into a sealed can within 1 week was released during the first 24 hours. No simple correlation between the gassiness of the coal stored and the methane concentration in the silo open space above the coal was found. This was probably because the gassier coals were stored in open-top silos, which were better ventilated. Although the methane concentration in the open space above the coal pile was less than 1 percent for all 34 silos investigated, a methane measurement in the coal pile showed that high methane concentrations can exist. The methane released appears to accumulate in the pile and not to diffuse freely into the open space above the coal pile. Probably this gas is released during reclaiming operations, but further research is required to substantiate this claim. The importance of ventilation in the silos and reclaiming areas in preventing the buildup of hazardous concentrations is emphasized.

25707 (COO/4427—1) **Evaluation of the effects of coal cleaning on fugitive elements. January 1, 1977—August 31, 1977.** Boyer, J.F. Jr.; Ford, C.T. (Bituminous Coal Research, Inc., Monroeville, Pa. (USA)). 23 Sep 1977. Contract EE-77-S-02-4427. 27p. (BCR-L—841). Dep. NTIS, PC A03/MF A01.

The objectives of the program are: To prepare a comprehensive state-of-the-art report on the effect of coal mining, preparation, transportation, and utilization on the trace elements found in coal; to determine the effect of coal cleaning on fugitive elements; and to provide a description of accurate analytical methods that can be used by coal industry and commercial laboratories for determining the concentration of selected trace elements in a variety of coals. Cleaning of the first of the twenty coals to be evaluated was completed. Chemical analysis of the numerous coal samples resulting from the preparation is progressing. Efforts continue to add analytical methods, where necessary, and to refine others for use on this project. While sufficient analytical data are not yet available to evaluate the effect of cleaning of the first coal on fugitive elements, aids to accomplish the evaluation, such as computer programs for data handling and material balances, have been developed. Searching and indexing of the needed reference materials is continuing.

25708 **Possibilities of improving the reliability of systems for automatic loading of coal bunkers.** Feofilov, G.P.; Paroder, S.Sh. *Sov. Power Eng. (Engl. Transl.);* 6: No. 9, 527-528(Sep 1977).

Translated from Elektr. Stn.; 6: No. 9, 34-35(Sep 1977).

Comparison of automatic bunker loading systems with full and partial centralization shows that full centralization is more complex and cannot provide a significant decrease in the amount of equipment. On the other hand, partial centralization permits a sharp decrease in the amount of equipment. Practice has demonstrated this. The reliability of automatic systems for control of the loading of raw coal bunkers can be improved by centralization of the operation of the primary measurement transducers due to the significant decrease of the amount of equipment used. In centralization of the operation of primary measurement transducers the signaling of the fuel level in the bunkers should use an unamplified variant based on gas discharge lamps with cold cathodes, which should increase the signaling reliability.

25709 **Analysis of pulverized fuel preparation systems equipped with different mills, for an 800 mw block fired by Kansk-Achinsk coal varieties.** Parilov, V.A.; Luzin, P.M.; Dronov, Yu.D. (Ivanovsk Energet Inst im. V.I. Lenin, USSR). *Izv. Vyssh. Uchebn. Zaved., Energ.;* No. 4, 62-66(Apr 1977). (In Russian).

Results of an analysis of a power unit equipped with fan mills, medium-speed and hammer mills are presented. It is shown that, from the point of view of explosion risk safety, availability and efficiency of the block for furnaces with solid slag removal, a system of p.f. preparation with direct blowing-in and medium-speed mills is optimal. For furnaces with liquid slag removal, a system of p.f. preparation with an open drying circuit and an intermediate storage bunker, equipped with medium-speed or hammer mills is recommended.

COMBUSTION

REFER ALSO TO CITATION(S) 25626, 25723, 26142, 26778, 26779, 26780, 26782

25710 (BNL—23765) **Regeneration of lime-based sorbents in a kiln with solid reductants.** Yang, R.T.; Chen, J.M.; Farber, G.; Shen, M.S.; Steinberg, M. (Brookhaven National Lab., Upton, N.Y. (USA)). 1977. Contract EY-76-C-02-0016. 15p. (CONF-771219—2). NTIS, MF A01.

From 5. international conference on fluidized bed combustion; Washington, DC, USA (12 Dec 1977).

Portions of document are illegible.

Processes based on apparent solid-solid reactions in a kiln-type reactor for regenerating the lime-based sorbents are being developed at our laboratory. The specific process investigated is to react the sulfated lime with fly ash, both from the fludiized-bed combustor (FBC). The unburnt carbon in the fly ash is used as the reductant. Eight-cycle sulfation-regeneration based on this scheme has been studied using Greer lime and fly ash from Argonne's 6-inch FBC as the starting materials. The apparatus included a rotary-kiln regenerator and a fluidized-bed sulfator, both with a ca. 10-gram capacity and made of quartz. The kiln temperature was 1000°C in the cyclic experiments. The SO_2 concentration reached the thermodynamic equilibrium values at slow gas flow rates. The reactivity of the regenerated sorbent did not decay appreciably after eight cycles; it actually tended to increase due to the impurities absorbed in the kiln. Completion of the regeneration of the 30%-sulfated stone from FBC could be reached in an hour with a time-averaged SO_2 concentration of 5% from the kiln. Attrition in the kiln is much less than in a FB regenerator. More results on the kiln regeneration are presented in this paper.

25711 (EPRI-FP—628) **Characteristics of solvent refined coal: dual register burner tests. Final report.** Sage, W.L.; Downs, W.; Cioffi, P.L. (Babcock and Wilcox Co., Alliance, Ohio (USA). Research Center). Jan 1978. 118p. Dep. NTIS, PC A06/MF A01.

This is the fourth and final report in a series dealing with B and W's efforts to support EPRI's continuing program to evaluate the suitability of solvent-refined coal (SRC) for use by the electric utility industry. This latest work was performed in 1976 in direct support of the then pending SRC combustion tests at Georgia Power's Plant Mitchell. Identification of retrofitting requirements for B and W E-type pulverizers and for the B and W dual register burner were the principal purposes of this work. Changes made to the pulverizer included lessening of the grinding pressure, slowing of the grinding elements, changing of the feeder controls, and operating with cold primary air. The dual register burner was equipped with a water-cooled coal nozzle, and eddy circulations were minimized in the vicinity of the burner front. These changes were necessary to prevent agglomeration and melting of the SRC in this equipment. All objectives were satisfactorily met and the field tests at Plant Mitchell were permitted to proceed as planned.

25712 (FE—2489-18) **Development of combustion data to utilize low-Btu gases as industrial process fuels. Project 8985 monthly status report, November 1—November 30, 1977.** Waibel, R.T. (Institute of Gas Technology, Chicago, Ill. (USA)). Dec 1977. Contract EX-76-C-01-2489. 14p. Dep. NTIS, PC A02/MF A01.

Base-line data were collected for natural gas on the kiln burner. Stability trials were completed for the low- and medium-Btu fuel gases and only Koppers-Totzek oxygen (KTO) was stable on a cold furnace at the natural gas input level of 3.5 million Btu/hr.

Wellman-Galusha air (WGA) was tried at 3.5 million Btu/hr on a hot furnace and produced a lifted but relatively stable flame. A complete set of tests were conducted with KTO and WGA after the stability trials.

25713 (FE—2516-4) **Centrifugal fluidized combustion of coal. Annual report for period ending September 1977.** Levy, E.K.; Chen, J.C. (Lehigh Univ., Bethlehem, Pa. (USA)). Oct 1977. Contract EX-76-S-01-2516. 44p. Dep. NTIS, PC A03/MF A01.

Small laboratory models of centrifugal fluidized beds were fabricated and batch experiments on bed startup and fluidization were performed at room temperature and atmospheric pressure. Experiments with cylindrical and conical distributors indicate it is difficult to start the bed from a slumped stationary position unless the distributor is tapered. The relationship between bed pressure drop and air flow rate is similar qualitatively to that of a conventional fluidized bed with apparent values for epsilon/sub mf/ in the range 0.38 to 0.45. Experiments with tapered distributors show strong effects of distributor angle, grid pressure drop, angular velocity, and bed mass on startup, minimum fluidization, and bed pressure drop. Theoretical analyses were developed to predict the influence of these factors on system performance; and comparisons of theoretical results with experimental data are presented. Test sections for the study of the feeding of solid material and the continuous removal of solids from a centrifugal fluidized bed were designed and built. In addition, studies of the flow patterns and velocity profiles of the gas flow within the centrifugal fluidized bed were initiated.

25714 (FE—2564-9) **Coal-oil slurry combustion demonstration, Phase I. Monthly report, November 1977.** Dunn, R.M. (New England Power Service Co., Westborough, Mass. (USA)). Dec 1977. Contract EF-76-C-01-2564. 12p. Dep. NTIS, PC A02/MF A01.

The combustion of a coal-fuel oil slurry in an 80 MW utility boiler originally designed to burn coal but now burning No. 6 fuel oil will be demonstrated. New low-pressure, air-atomized oil burners will be installed. The stability of coal-oil mixtures produced with various commercially available blending equipment is being investigated in the laboratory. Stability is also being evaluated using various dispersant additives. This work will support the selection of coal preparation and slurry blending equipment.

25715 (FE—2564-10) **Coal—oil slurry combustion demonstration, Phase I. Monthly report, December 1977.** Dunn, R.M. (New England Power Service Co., Westborough, Mass. (USA)). Jan 1978. Contract EF-76-C-01-2564. 14p. Dep. NTIS, PC A02/MF A01.

The combustion of a coal-oil slurry in an 80 MW utility boiler originally designed to burn coal but now burning No. 6 oil will be demonstrated. New low pressure air atomized oil burners will be installed. The stability of coal-oil mixtures produced with various commercially available blending equipment is being investigated in the laboratory. Stability is also being evaluated using various dispersant additives. This work will support the selection of coal preparation and slurry blending equipment. Progress is reported, but material delivery delays and uncertainties have made it necessary to reschedule burner installation from January to May, 1978.

25716 **Burning rate of carbon in fluidized beds.** Basu, P. (Cent Mech Eng Res Inst, Durgapur, West Bengal, India). *Fuel;* **56**: No. 4, 390-392(Oct 1977).

An experimental method for determining the rate of burning of a carbon sphere within a fluidized bed of sand is described. Experiments have been carried out at three different bed temperatures. Measured values were compared with theoretical values and they were found to be in reasonable agreement. The difference between the core temperature of the carbon sphere and that of the bed was found to increase with diminishing size of the sphere. 9 refs.

25717 **Mathematical modelling of coal combustion in fluidized beds with sulphur emission control by limestone or dolomite.** Chen, T.; Saxena, S.C. (Univ of Ill, Chicago Circle). *Fuel;* **56**: No. 4, 401-413(Oct 1977).

A model is developed for the combustion of coal in fluidized beds with sulphur emission control by limestone or dolomite. The gas and solid flow analysis is based on multiple gas bubbles of varying sizes which, accompanied by the cloud and wake, rise through the particulate emulsion phase. Solids population balance relating the feed, overflow, and elutriation with the physiocochemical changes of particles in the bed is carried out for coal and sulphur-absorbent respectively. The reactions in the bed are then formulated in terms of the above determined gas velocities and distribution functions for solids. Experimental data from various pilot-plant operations are used to assess the validity of the proposed model. 32 refs.

25718 **Ignition of droplets of liquid fuels solvent extracted from coal.** Jordan, J.B.; Kimber, G.M.; Williams, A. (Univ of Leeds, Engl). *Fuel;* **56**: No. 4, 417-421(Oct 1977).

A single suspended-droplet technique has been used to study droplet combustion of a range of solvent-refined coal extracts in a furnace at 850$degree$C. The small particles of extract are solid at room temperature but they rapidly liquefy on exposure to the hot furnace environment, permitting the size and mass--time combustion histories to be measured. Their combustion behavior is discussed in terms of their high aromaticity and comparison with the single droplet combustion of fuel oils of different asphaltene content was used to highlight potential solids emissions problems which may arise when firing in large systems. 27 refs.

MARKETING AND ECONOMICS

25719 (ANL/AA—12) **National coal utilization assessment: the price and availability of low sulfur coal in eastern markets.** Krohm, G.C.; Dux, C.D. (Argonne National Lab., Ill. (USA)). Jul 1977. Contract W-31-109-ENG-38. 54p. Dep. NTIS, PC A04/MF A01.

This study examines the regional market patterns for low sulfur coal through 1985. Regional coal demands and price-quantity relationships for coal supply are estimated. Demand and supply are integrated within a formal model of interregional coal markets. Minemouth and delivered prices of low sulfur coal are computed, as well as the market boundary between Western and Eastern coal supply regions. Finally, potential transportation, mining equipment, and labor constraints on expanded low sulfur coal production are examined.

25720 (ANL/AA—13) **National coal utilization assessment: modeling long-term coal production with the Argonne coal market model.** Dux, C.D.; Kroh, G.C.; VanKuiken, J.C. (Argonne National Lab., Ill. (USA)). Aug 1977. Contract W-31-109-ENG-38. 40p. Dep. NTIS, PC A04/MF A01.

The Argonne Coal Market Model was developed as part of the National Coal Utilization Assessment, a comprehensive study of coal-related environmental, health, and safety impacts. The model was used to generate long-term coal market scenarios that became the basis for comparing the impacts of coal-development options. The model has a relatively high degree of regional detail concerning both supply and demand. Coal demands are forecast by a combination of trend and econometric analysis and then input exogenously into the model. Coal supply in each region is characterized by a linearly increasing function relating increments of new mine capacity to the marginal cost of extraction. Rail-transportation costs are econometrically estimated for each supply-demand link. A quadratic programming algorithm is used to calculate flow patterns that minimize consumer costs for the system.

25721 (IIASA-CP—77-5) **Medium-term aspects of a coal revival: two case studies.** Sassin, W.; Hoffmann, F.; Sadnicki, M. (eds.). (International Inst. for Applied Systems Analysis, Laxenburg (Austria)). Aug 1977. 91p. Dep. NTIS (US Sales Only), PC A05/MF A01.

Report of the IIASA Coal Task Force.

An important purpose of the work was to develop a methodology for exploring future demands for coal on the basic assumption that coal will provide the key to the global-energy-supply problem. This methodology must take into account both the long-term supply aspects and the energy system that exists today. We concluded that a methodology for analyzing the coal option must start by investigating selected geographical regions; and further, that any such study must first consider both the quantity and the form (solid, liquid, and networked) of energy demanded by the final consumer. The two regions chosen for analysis, the FRG and the UK, both have sizeable existing coal industries, but in the medium term face different strategy choices as a result of differences in indigenous energy resources, existing energy systems, and the nature of demand. The results indicate that a coal option must be considered a real possibility in both countries. The analysis quantifies a gradual shift in the uses of coal. The introduction of new conversion technologies is assumed. A planned program for expanding the coal supply is obviously necessary. The coal industries in both regions would find it difficult to satisfy continuing increases in demand around and certainly beyond the year 2000. Given the long lead times involved, substantial new R and D effort in new mining techniques is required now. A massive effort of coordination and investment must be made at a time when coal consumption is stagnating or even declining. It is premature to prepare detailed programs for the expansion of coal on the basis of the case studies reported here. Nevertheless if coal is to be promoted to the position of an energy policy option, such programs should be investigated in detail as soon as possible.

25722 (TID—28133) **Annual summary of cost and quality of electric utility plant fuels, 1976.** (Federal Power Commission, Washington, D.C. (USA). Bureau of Power). May 1977. 162p. Dep. NTIS, PC A08/MF A01.

In 1976 the demand for electric energy rose 6.2%, reaching a new record of 2037 billion kilowatt-hours, as the Nation began its recovery from the 1974-75 economic recession. The bulk of the generation growth was in coal and oil-fired units; both increased

10.7% to reach all-time highs. Electric utility use of oil, which had been declining for two years following the Arab oil embargo in the fall of 1973, increased by nearly 50 million barrels and came within 4 million barrels of the 1973 record consumption. However, compared with 1973, electric utility use of oil was 2.3% more efficient due to new oil-fired units and more prudent use of peaking units. Gas-fired generation and gas consumption continued to decline for the fourth consecutive year, but at a significantly lower rate. In 1976, As in the prior four years, all of the decrease in electric utility gas usage was in areas outside the West South Central Region (Texas, Oklahoma, Louisiana, and Kansas) where consumption of gas continued to increase and 68% of the gas used by the Nation's utilities was consumed. Clearly, meaningful future reductions in gas usage will be possible only if the trend in the WSC Region is reversed. The utilities in this region have developed a positive plan for reducing the use of gas significantly in the years ahead; some of this reduction will undoubtedly be attained by the substitution of oil for gas. Nuclear generation, although up 10.4%, was well below the 46% average annual growth rate during the four-years prior to 1976. The electric utility fossil fuel bill continued to climb, both because of increased overall quantities consumed and increased unit costs of coal and gas. Thus, in 1976 the estimated cost of fossil fuels consumed by the Nation's electric utilities was $18.3 billion.

25723 Future use of coal in energy generation. Delannoy, G. (Cent d'Etud et de Rech des, Charbon de Fr). *Rev. Gen. Therm.;* **32**: No. 8, 627-632(Aug 1977). (In French).

During the last 15 years the oil has largely replaced the use of coal for power generation. A review is given about the reasons for a larger interest in utilization of coal for heating and steam generation. An evaluation is given of the present methods for gasification of coal in situ and hydrogenation of coal.

HEALTH AND SAFETY

REFER ALSO TO CITATION(S) 25676, 25690, 25691, 25693, 26419

25724 Precautionary measures to reduce the probability of incipient heatings in coal mines, their early detection and safety procedures in dealing with colliery fires. Barnes, V.C.; Joubert, F.E.; Badenhorst, G.P. *J. Mine Vent. Soc. S. Afr.;* **30**: No. 8, 143-155(Aug 1977).

The liability of South African coals to spontaneous combustion is described. Mine layout and design to minimize the incidence of self-heating is discussed. Research progress in early detection of incipient fires is reported. Safety procedures dealing with colliery fires and re-opening sealed areas are summarized. 4 refs.

25725 Methods of protection of obviate hazardous sparkaing in explosion-proof luminaries with fluorescent lamps. Vainshtein, Yu.D.; Iokhel'son, Z.M.; Machugovskii, N.B. (Inst of Work Saf in the Min Ind, Makeevka, Usr SSR). *Svetotekhnika;* No. 8, 5-7(Aug 1977). (In Russian).

It is found that the existing interlocks in explosion-proof fluorescent luminaries do not ensure the initial parameters of protection against explosion under operational conditions. The possibility of eliminating hazardous sparking in the electrode circuit of fluorescent lamps, up to 40 W, by using special transformer type ballast with heating circuits that present no risk of sparking, is determined. This increases the interlock response time from 4 to 100-200 ms and simplifies the design the device, improving at the same time the reliability of the protection against explosion.

PETROLEUM

RESERVES

REFER ALSO TO CITATION(S) 25817

25726 Possible future petroleum of Uinta and Piceance basins and vicinity: northeast Utah and northwest Colorado. Sanborn, A.F. (Chevron U.S.A. Inc., Denver). pp 151-166 of Exploration frontiers of the central and southern Rockies. Veal, H.K. (ed.). Denver; Rocky Mountain Association of Geologists (1977).

From Symposium program RMAG fall field conference; Snowmass, CO, USA (29 Sep 1977).

See CONF-770972—.

In northeast Utah and northwest Colorado, every geologic system from Pennsylvanian through Tertiary contains oil- and gas-productive strata. Most of the larger oil and gas fields produce from folded stratigraphic traps. Except for production from fractured Tertiary and Cretaceous rocks, production is from porous sandstone reservoirs. Potential for future development of large oil and gas reserves is estimated to be very good. Estimated ultimate recoverable reserves in excess of 3 billion bbl of oil and 5 trillion cu ft of gas are possible. Future production is expected to be largely from new fields and pools in the strata that are now productive. There is additional petroleum potential in Mississippian and Pennsylvanian carbonate rocks that are not yet productive in the area. Most of the new oil and gas probably will be found in stratigraphic traps in sandstone reservoirs. Deeper structural features, located by geophysical means, should reward the explorer with significant new reserves.

GEOLOGY AND EXPLORATION

25727 Relations between the depth and surface tectonics of the Urals and Priurals and their significance in searching for oil and gas. Offman, P.E.; Bush, E.A. (Inst. of Geology, Moscow). *Izv. Akad. Nauk SSSR, Ser. Geol.;* No. 1, 93-103(Jan 1977). (In Russian).

It is pointed out that the tectonic forms developed in the near-surface part of the crust mask the tectonic structures found in the deeper parts of the crust. Thus the problem of finding oil and gas in the Urals is a problem of tectonics. It is shown that trenchlike downwarpings of different ages determine the tectonic layout of the Urals and Priurals. In addition it is explained that in forming the deeper structures of endogenous origin a series of secondary types of dislocations of gravigenic and chemogenic origin were formed with masking of the core structures and also those which may contain commercial accumulations of gas and oil. 9 figures, 22 references. (SJR)

25728 Effect of thermal field on oil—gas formation in mesozoic deposits of the Western Siberian plate. Sergienko, S.I. *Izv. Akad. Nauk SSSR, Ser. Geol.;* No. 1, 104-114(Jan 1977). (In Russian).

A discussion is presented on the field and experimental studies of the thermal field in oil- and gas-bearing regions of the Western Siberian plate, and a look is taken at the mutual relation of the thermal field parameters with regularities in the spacial distribution of hydrocarbon deposits and with the physical-chemical properties of strata oils. From the data of 98 determinations a schematic map is composed for the distribution of thermal flux over the territory of Western Siberia. Five zones which are characterized by a difference in the density of the depth thermal flux are separated out. Gas or gas-condensate deposits are associated with zones of regional maxima in the thermal flux field. Oil deposits are associated with zones having average values of the thermal flux field, while regions poor in oil and gas deposts are characterized by low values of the thermal flux field. It is shown that data of geothermal studies the regions in the north of the West Siberian plate have good prospects for finding oil.An analysis is made of the effect of the energy flow in the earth's crust of concrete tectonic structures of the Western Siberian plate on the geochemical appearance of oils in sedimentary collectors. It is shown that the thermal field as a whole, and not only the temperature in the deposits, controls the physical-chemical properties of the oils. 17 refs., 2 figs., 5 tables. (SJR)

25729 Exploration frontiers of the central and southern Rockies. Veal, H.K. (ed.). Denver; Rocky Mountain Association of Geologists (1977). 499p. (CONF-770972—). .

From Symposium program RMAG fall field conference; Snowmass, CO, USA (29 Sep 1977).

Papers are presented on structural geology, oil and gas exploration, uranium exploration, geothermal exploration, coal deposits, mineral exploration, and geology. A separate abstract was prepared for each of 26 papers. (JRD)

25730 Structural style in relation to oil and gas exploration in North Park-Middle Park basin, Colorado. Wellborn, R.E. (Burton/Hawks, Inc., Casper, WY). pp 41-60 of Exploration frontiers of the central and southern Rockies. Veal, H.K. (ed.). Denver; Rocky Mountain Association of Geologists (1977).

From Symposium program RMAG fall field conference; Snowmass, CO, USA (29 Sep 1977).

See CONF-770972—.

North Park-Middle Park basin is one of the smaller of the intermontaine basins and one of the more structurally complex. Several stages of Laramide tectonism occurred, ultimately creating thrust faults with over 10,000 feet of displacement along the east and north margins of the basin, and within the basin itself. Thrusting was directed generally in a westerly and southwesterly direction. In places, pre-Tertiary erosion breached sediments on the intrabasin thrusts down to rocks of Dakota age or older. Additional thrusting is found throughout the basin, occurring as bedding-plane thrusts or detachments. Thrusts appear to be present in all of the structures examined, some with displacements up to several thousand feet. Direction of bedding plane thrusting is generally out of the basin, as a result of sharp synclinal basin folding; in many cases detachment-folds were formed, and these folds are thought by the author to contain most of the oil and gas production in the basin. The basin is

still in the early stages of exploration, with relatively few wildcat wells located away from the existing producing areas. The southern half of the basin is sparsely drilled, with no oil or gas production to date. Field geology must be coordinated with existing well control and seismic data, utilizing sound structural geologic techniques, to find hidden structures and to reevaluate unsuccessfully drilled structures. Attention should also be given to potential stratigraphic traps and fracture production within the basin.

25731 Oil potential of Mesozoic sediments beneath the Independence Mountain thrust fault, North Park, Colorado. Park, G.M. (Wyoming Corp., Billings, MT). pp 61-66 of Exploration frontiers of the central and southern Rockies. Veal, H.K. (ed.). Denver; Rocky Mountain Association of Geologists (1977).

From Symposium program RMAG fall field conference; Snowmass, CO, USA (29 Sep 1977).

See CONF-770972—.

Independence Mountain, a large thrust block at the northern end of North Park basin, is interpreted to have been thrust southward more than 12 miles covering more than 90 square miles of potential oil and gas producing rocks. It is believed that the last stage of the Laramide orogeny was manifested by the Independence Mountain thrust which cuts across all earlier structures and can be related to regional plate tectonics. The Independence Mountain thrust can be traced more than 40 miles from northeast of Pearl in the Park Range, around the nose of Independence Mountain and northeast to the crest of the Medicine Bow Range. Twelve million barrels of oil and 500 million cubic feet of gas have been produced from more than 60 wells in North Park basin, Colorado. Production is from Triassic, Jurassic and Cretaceous sedimentary rocks in fault and anticlinal traps. The northwest-trending subparallel alignment of the oil-producing structures in North Park are interpreted to continue under the upper plate of the Independence fault. The gently sloping plane of the thrust indicates that sediments can be reached beneath the thrust plate at depths ranging from 1,500 feet in Wheeler Creek to 3,500 feet along the state line at Sixmile Creek.

25732 Interpretation of seismic reflection data from the central South Park basin, Colorado. Beggs, H.G. (Seismograph Service Corp., Tulsa, OK). pp 67-76 of Exploration frontiers of the central and southern Rockies. Veal, H.K. (ed.). Denver; Rocky Mountain Association of Geologists (1977).

From Symposium program RMAG fall field conference; Snowmass, CO, USA (29 Sep 1977).

See CONF-770972—.

The search for hydrocarbons has been carried out in South Park basin since the 1920's with no economic success. The primary exploration target has been Cretaceous sandstones beneath the Hartsel anticline in east-central South Park. Of the approximately 20 wells drilled in the basin, only a few reported good oil shows and none have economic production. Approximately 56 miles of seismic data collected by the Colorado School of Mines since 1962 have been recently interpreted. Despite the extensive earlier work these data were tied only to a few available well logs and reliable surface geologic maps in order to make an independent interpretation of the tectonic style and structural history of east-central South Park. Results of this interpretation support some of the prior studies in the area, but there are several significant differences: (a) vertical basement-controlled tectonics, instead of lethal "thin-skin" tectonics appear to control the structural style in this area. The basic subsurface configuration is an asymmetric faulted north-south trending syncline bounded by large basement uplifts associated with the Elkhorn fault on the east and the Santa Maria and South Park faults on the west. (b) The Hartsel anticline is an anomalous feature on the west flank of the central syncline. (c) The basement uplift in the western part of the study area is termed the Santa Maria uplift and was believed to have formed the extreme western margin of the late Paleozoic Front Range highland. (JRD)

25733 Seismic investigation of the Colorado Front Range Zone of flank deformation immediately north of Golden, Colorado. Davis, T.L. (Univ. of Calgary, Alberta); Young, T.K. pp 77-88 of Exploration frontiers of the central and southern Rockies. Veal, H.K. (ed.). Denver; Rocky Mountain Association of Geologists (1977).

From Symposium program RMAG fall field conference; Snowmass, CO, USA (29 Sep 1977).

See CONF-770972—.

Interpretation of approximately 40 miles of reflection seismic data acquired by the Colorado School of Mines Geophysics Department in conjunction with surface maps and well data reveals a "Laramide" structural style of faulting associated with the Colorado Front Range zone of flank deformation. This Laramide system is dominantly vertical in nature and is basement controlled. Fault displacement varies with depth and spatially from block to block within the total system. Departure from the vertical fault plane orientation does not exist immediate to the Front Range flank and is governed by the amount of fault displacement and the nature of the rock types brought into juxtaposition by the faulting. Drape folding is the dominant structural style in the uppermost sedimentary section involved in the Laramide faulting. Potential exists for hydrocarbon entrapment in block fault structures where fracture porosity and permeability exist.

25734 Fractured shale hydrocarbon reservoirs in southern Rocky Mountain basins. Mallory, W.W. (U.S. Geological Survey, Denver). pp 89-94 of Exploration frontiers of the central and southern Rockies. Veal, H.K. (ed.). Denver; Rocky Mountain Association of Geologists (1977).

From Symposium program RMAG fall field conference; Snowmass, CO, USA (29 Sep 1977).

See CONF-770972—.

Cumulative production of oil from fractured shale is 3 percent of that from all formations in Colorado and 11 percent in northwestern New Mexico. Thick Cretaceous shales are widespread in the region and contain oil-filled void fractures in three districts, the west flank of the Denver basin, northwest Colorado, and the rim of the San Juan basin. In contrast to conventional pore-permeability hydrodynamic reservoirs, fracture pools consist of planar voids with gas solution and gravity drive. Exploration and completion practices also differ. Geophysical methods seem to be ineffective; anticlines are not preferred traps; water-base muds are detrimental. New prospects should be present near producing fields and along presently undrilled structural trends specified in the text.

25735 Seismic stratigraphic exploration: a new frontier. Lindseth, R.O. (Teknica Ltd., Calgary, Alberta). pp 107-116 of Exploration frontiers of the central and southern Rockies. Veal, H.K. (ed.). Denver; Rocky Mountain Association of Geologists (1977).

From Symposium program RMAG fall field conference; Snowmass, CO, USA (29 Sep 1977).

See CONF-770972—.

The development of seismic equipment, techniques and interpretive skills to explore for stratigraphic traps can be considered a new frontier in exploration technology. The seismic reflection method has been a useful and reliable tool for mapping structure but has not been as well suited to mapping of stratigraphy. Certain new seismic techniques help to overcome this deficiency by providing higher resolution. Another technique is directed toward producing synthetic sonic logs (Seislogs) from seismic traces. This has a number of advantages including increased stratigraphic resolution, direct depth measurements, and direct correlation to well control. However, the major advantage is the ability to display and map lateral velocity changes which are often directly related to facies changes. Thus, under favorable conditions, porosity can be mapped directly from seismic data. The inversion or conversion of seismic traces to Seislog traces provides a better means for interpretation of seismic data. It is still subject to the weaknesses in remote-sensing, seismic-reflection data acquisition and possible errors in data correlation, such as porosity to shale velocity matches.

25736 Biostratigraphic correlation of the Mesaverde Group in southwestern Wyoming and northwestern Colorado. Miller, F.X. (Amoco Production Co., Denver). pp 117-137 of Exploration frontiers of the central and southern Rockies. Veal, H.K. (ed.). Denver; Rocky Mountain Association of Geologists (1977).

From Symposium program RMAG fall field conference; Snowmass, CO, USA (29 Sep 1977).

See CONF-770972—.

The Mesaverde Group in southwestern Wyoming and northwestern Colorado represents a complex intertonguing of the Upper Cretaceous (Montanan) marine strata of eastern Wyoming and Colorado with the non-marine strata of north-central Utah. Paleontologic control in the marine strata is sufficient to permit accurate biostratigraphic correlations based on time. To the west, paleontologic data from the nearshore marine and continental deposits are incomplete or absent. As a result, current stratigraphic correlations of the Mesaverde Group are based on non-synchronous lithologic data. The stratigraphic correlations presented in this paper are based on the occurrence of palynologic microfossils identified in samples from wells and outcrop sections in Wyoming and Colorado. Time lines used to illustrate the chronostratigraphic relationship of the Mesaverde Group in different basins are established using the stratigraphic ranges of the palynologic microfossils and the graphic correlation technique of Shaw (1964). Formation names within the Mesaverde Group differ from basin to basin. The purpose of this paper is to place the various formations comprising the Mesaverde Group in the Green River basin, Rock Springs uplift, Washakie, Red Desert, Sand Wash and the northern Piceance basins in their proper chronostratigraphic order. Evidence of a widespread unconformity within the Mesaverde Group is presented. Broad regional arching accompanied by erosion occurred over most of southwestern Wyoming prior to deposition of the Ericson Sandstone. The extent of the unconformity and its overall effect on the stratigraphic section have not been fully realized in the past. Recognition of this unconformity requires a reinterpretation of the depositional and tectonic history of the Mesaverde Group of southwestern Wyoming. This interpretation coincides with events described by Gill and Cobban (1966) in the

Powder River and Big Horn basins, and by Reynolds (1966) in the Great Divide basin.

25737 Petroleum potential of southwestern Wyoming and adjacent areas. Adams, O.C.; Oline, W.F. pp 139-150 of Exploration frontiers of the central and southern Rockies. Veal, H.K. (ed.). Denver; Rocky Mountain Association of Geologists (1977).

From Symposium program RMAG fall field conference; Snowmass, CO, USA (29 Sep 1977).

See CONF-770972—.

Southwestern Wyoming and adjacent areas in northwestern Colorado and northeastern Utah have had a favorable depositional and structural history for the formation and accumulation of significant amounts of hydrocarbons. The 89,420 cu mi sedimentary package contains sediments of all periods except the Silurian. Hydrocarbons are produced from all but Ordovician and Devonian age sediments in a variety of structural and stratigraphic traps. An optimistic future is predicted to greatly improve the estimated original in place reserves of 1.8 billion bbl of oil and 7.3 trillion cu ft of gas, by deeper drilling on producing structures, and presently undefined structural and stratigraphic traps in the deeper portions of the basins.

25738 Geology and petroleum of the Mancos B formation, Douglas Creek arch area, Colorado and Utah. Kellogg, H.E. pp 167-179 of Exploration frontiers of the central and southern Rockies. Veal, H.K. (ed.). Denver; Rocky Mountain Association of Geologists (1977).

From Symposium program RMAG fall field conference; Snowmass, CO, USA (29 Sep 1977).

See CONF-770972—.

The Mancos B Formation is a complex of intimately interbedded and interlaminated claystone, siltstone, and fine sandstone formed in a marine environment about 100 miles east of the Emery shoreline. The lower Mancos B was deposited as east-west trending, northward prograding fore slope sets built on a sub-horizontal ocean floor; sandy facies are found as far north as Douglas Creek anticline but rapidly change to a shaly facies farther north. Deposition of the upper Mancos B began with an influx of sandy material, probably from the west, that filled an erosional topographic low in the North Douglas Creek area and spread southward; some clastics continued to enter the area from the south or southwest. The formation is "sandiest" at Douglas Creek anticline, where it is about 500 feet thick, and "shaliest" in the southeast, where it can be over 1000 feet thick. The Mancos B has low porosity (average 10-11%), low permeability (average 0.7 md), and is very sensitive to formation damage by introduced water. Its emergence as a significant producer of natural gas has therefore been largely dependent upon the development and application of air drilling techniques and of massive pseudolimited entry fracture treatments. Over 127 BCF of gas has been produced from the formation in the last ten years, mostly from Douglas Creek anticline. Only a little over 20,000 bbls. of oil have been produced but it now appears that as much as 1,400 feet of oil column may be present beneath the gas cap. Increased drilling activity is extending the known producing area southward on the Douglas Creek arch. As yet no productive limits are known other than those dictated by economics.

25739 Shallow marine deposits in the Upper Cretaceous Pierre Shale of the northern Denver basin and their relation to hydrocarbon accumulation. Kiteley, L.W. (U.S. Geological Survey, Denver). pp 197-211 of Exploration frontiers of the central and southern Rockies. Veal, H.K. (ed.). Denver; Rocky Mountain Association of Geologists (1977).

From Symposium program RMAG fall field conference; Snowmass, CO, USA (29 Sep 1977).

See CONF-770972—.

In the northern Denver basin the upward increase in a northwestward direction from Boulder, Colorado, of sandstone interbeds within the Pierre Shale indicates a major eastward regression of the strandline. Analyses of outcrop data suggest that the lower third of the Pierre was deposited in open-marine environments, the middle third in shallow marine environments, and the upper third in open-marine to very near shore environments. Computed rates of deposition for the Hygiene and Terry Sandstone Members indicate that the source of sand for these members probably was a delta, which lay to the north and northwest in north-central Colorado and south-central Wyoming. The rapid accumulation in this area, where both the Hygiene and Terry produce oil and gas, is believed to have favored preservation of potential source rocks. The criteria for production at Spindle-Surrey and Singletree oil fields are (1) a local subsiding basin, in which rapid accumulation of fine-grained sediments produced a favorable regime for preservation of potential source rocks; and (2) potential reservoir sandstones lying above and updip from these source rocks. In the Pierre Shale, the Rocky Ridge, Larimer, and Richard Sandstone Members, and member A (unit A of Kiteley, 1976) offer favorable reservoir conditions for future exploration in many parts of the northern Denver basin. Members B and C (units B and C of Kiteley, 1976) are less favorable than the more deeply buried member A, because of lowered porosity and permeability in member B, and probable communication with surface waters in member C.

25740 Recognition of fossil karst features in the ancient record: a discussion of several common fossil karst forms. Maslyn, R.M. pp 311-319 of Exploration frontiers of the central and southern Rockies. Veal, H.K. (ed.). Denver; Rocky Mountain Association of Geologists (1977).

From Symposium program RMAG fall field conference; Snowmass, CO, USA (29 Sep 1977).

See CONF-770972—.

Fossil karst is a general term for those karst features formed in the distant geologic past and now preserved beneath younger sediments. These features are important indications of periods of uplift of carbonate rock and subaerial exposure. Additionally, such karst development may alter carbonate rock porosity and influence its reservoir characteristics. Fossil karst features are widespread in the United States, having developed at various times during the Paleozoic, Mesozoic, and part of the Cenozoic. The two most notable episodes of karstification, however, occurred in the post-Lower Ordovician and in the Late Mississippian. Both of these episodes left locally developed karst features including an erosional karst topography, carbonate soil breccias, filled caves, sinkholes, and residual karst towers over a widespread area. Silicification accompanied the karsting in some areas, replacing the carbonate breccia fragments and the carbonate wall rock around some of the fossil karst sinkholes. Positive features such as karst towers extend into the overlying sediments which fossilized them. Similar features have served as a base for later reef growth and influenced carbonate sedimentation patterns. The recognition of such fossil karst towers in the ancient record thus may be of importance in locating areas of potential hydrocarbon accumulation.

25741 Preliminary report: petroleum geochemistry of the Denver basin. Clayton, J.L. (U.S. Geologica Survey, Denver); Swetland, P.J. pp 223-233 of Exploration frontiers of the central and southern Rockies. Veal, H.K. (ed.). Denver; Rocky Mountain Association of Geologists (1977).

From Symposium program RMAG fall field conference; Snowmass, CO, USA (29 Sep 1977).

See CONF-770972—.

Crude oil and shale samples from the Denver basin of Colorado, Wyoming, and Nebraska were analyzed using organic geochemical techniques to determine oil-shale bed relationships. In general, oils in Cretaceous reservoirs are compositionally similar throughout the basin and are geochemically dissimilar to the oil produced from Permian Lyons Sandstone. The Cretaceous oils are compared with hydrocarbon extracts from Cretaceous shales to determine the stratigraphic occurrence and regional distribution of petroleum source beds. The results show that oils produced from the Cretaceous Terry and Hygiene Sandstone Members of the Pierre Shale, "D", and "J" sandstone reservoirs have probably been derived from the Carlile, Greenhorn, Graneros, and Mowry Formations. The source bed for oil from the Lyons has not yet been identified. Samples of the Carlile-Greenhorn-Graneros-Mowry interval have been analyzed throughout the basin. Only samples from the basin-axis area contained hydrocarbon distributions similar to those Cretaceous oils. The occurrence of petroleum on the east flank of the basin, in light of the limited geographic distribution of effective source beds, indicates that extensive (as much as about 150 km) lateral migration has occurred. This suggests that an understanding of lateral migration pathways is important for petroleum exploration in the Denver basin.

25742 Experience of application of multidimensional regression analysis in connection with integrated interpretation of local gravitational anomalies of structurally complex regions of Azerbaijan. Amiraslanov, T.S. (Az SSR Inst of Pet and Chem im. M. Azizbekov). *Izv. Vyssh. Uchebn. Zaved., Neft Gaz;* No. 5, 6-10(1977). (In Russian).

A method of integrated interpretation of local gravitational anomalies, using multidimensional regression analysis (MRA), is presented. This method has been worked out on the examples of a number of structurally complex oil and gas-bearing regions of Azerbaijan: the Nakhichevan region, the north-western part of the Kirovabad region, and the interfluve between the rivers Kura and Iori. The main stages of integrated interpretation are singled out, problems of application of MRA are analyzed. Some results of using the proposed method are presented. 13 refs.

25743 Geology of the Amoco Imp Skelly A-1 Osprey H-84 well, Grand Banks, Newfoundland. Jansa, L.F.; Gradstein, F.M.; Williams, G.L.; Jenkins, W.A.M. *Geol. Surv. Can., Pap.;* No. 77-21, vp(1977).

This report describes the lithostratigraphy, biostratigraphy, and depositional history of the Amoco Imp Skelly A-1 Osprey H-84 well, located in the Carson Basin on the southeastern Grand Banks, approximately 250 statute miles southeast of St. John's, Newfoundland. A marine transgression in the Hettangian-Sinemurian resulted in the deposition of carbonates, which are immediately overlain by

marine Upper Cretaceous clastics and marls. The regional geology indicates that deposition occurred in the Jurassic and Lower Cretaceous. No indications of oil stain were observed in cuttings of the Osprey well. The Triassic and lower Jurassic rocks lack porosity. High porosity is present in unconsolidated Tertiary sand beds, but no hydrocarbon accumulation was encountered in the Osprey well. 21 refs.

25744 Regularities in the arrangement and formation conditions of zones of oil and gas accumulation in jurassic deposits of south Russia. Stroganov, V.P. *Sov. Geol.;* No. 11, 38-53(Nov 1976). (In Russian).

On the basis of present-day theoretical concepts an analysis is carried out on the conditions of forming zones of gas- and oil-accumulation in jurassic deposits of the Skifskii and Turanskii plates. Zones of gas accumulation were formed in those regions (Eastern Kubanskii depression and the Amudar'inskii synclise), where conditions were favorable for storing gas generated earlier, and where methane was generated at greater depths to a definite degree. In these regions the lower-midjurassic, productive ores rapidly passed through the upper zone of slight depth, and were reliably covered over with an impenetrable thick salt layer. Zones of oil accumulation were formed in regions where there was organic matter of a sapropelic type in the lower-midjurassic stratum and the conditions of preserving and accumulating gas were, conversely, unfavorable. Here the ancient traps were free of gas and could freely accumulate oil. It is noted that the formation of oil and gas deposits can be considered as a unified whole within the boundaries of the entire, young platform of South Russia. In addition, differences are also noted that are associated with specific features of separate regions, in particular, with the tectonic features of the Skifskii plate, which is as it were a "prikavkaz shield". 2 tables, 4 figures, 31 references. (SJR)

DRILLING AND PRODUCTION

REFER ALSO TO CITATION(S) 26784

25745 (BERC—77/4) Contracts and grants for cooperative research on enhanced oil and gas recovery and improved drilling methods. Progress review No. 12. Linville, B. (ed.). (Department of Energy, Bartlesville, Okla. (USA). Bartlesville Energy Research Center). Dec 1977. 134p. Dep. NTIS, PC A07/MF A01.

Short status reports are given on field projects and supporting research on micellar-polymer flooding, improved waterflooding, carbon dioxide injection, thermal/heavy oil recovery, enhanced gas recovery by massive hydraulic fracturing, and eastern gas shales. (LK)

25746 (BERC/RI—77/15) Review of petroleum oil saturation and its determination. Donaldson, E.C.; Crocker, M.E. (Department of Energy, Bartlesville, Okla. (USA). Bartlesville Energy Research Center). Dec 1977. 48p. Dep. NTIS, PC A03/MF A01.

A review is presented of the literature on several aspects of petroleum reservoir oil saturation and its determination. The influence of the wettability of the rock-oil-water system on the microscopic structure of oil saturation is discussed from a background of experimental work conducted at BERC as well as a review of the literature. The general conclusion is that the wetting phase occupies the small pores and coats the surface of the larger pores. A summary of the gross distribution of oil saturation that remains at the end of waterfloods using various well patterns is presented and the methods of laboratory analysis of cores obtained from oilfields are discussed. Core analysis is capable of measuring the distribution of oil saturation in a reservoir, but it is too costly and time-consuming to be applied to a complete field; therefore, its results are complemented by well logs to achieve an economical evaluation of oil saturation. In addition, brief explanations of the procedures and utility of various well logging techniques are presented.

25747 Salinity tolerant surfactant oil recovery process. Carlin, J.T.; Ware, J.W.; Mills, M.E. Jr.; Wells, J.A. (to Texaco Inc.). US Patent 4,066,124. 3 Jan 1978. Filed date 1 Dec 1976. 14p.

Primary anionic surfactants such as organic sulfonates are effective for recovering oil from subterranean formations only if the salinity and/or hardness of the formation water is relatively low. In petroleum formations containing high salinity, or hard water, either the high salinity water must be displaced by a preflush or the primary anionic surfactant must be used in conjunction with an effective solubilizing co-surfactant, such as ethoxylated alcohols or alkyl phenols, or alkyl or alkylaryl thiols, as well as sulfated or sulfonated, ethoxylated alcohols or alkyl phenols. Optimum performance is achieved if two or more samples of petroleum sulfonate having different equivalent weight ranges and distributions are blended in a ratio which requires the minimum amount of solubilizing cosurfactant to achieve a condition of borderline solubility in the particular formation water in which the surfactants are to be employed. This ratio may be identified by preparing a number of blended petroleum sulfonate samples in the formation water using different ratios of total primary surfactant concentration to solubilizing co-surfactant concentration, and determining whether borderline solubility is achieved, by direct observation or by identifying the sample which produced the minimum electrical conductivity, or at which point the conductivity vs. concentration ratio curve exhibits an inflection point.

25748 Experience with instrument systems on North Sea oil and gas production platforms. Hepworth, H. (Shell UK Exploration and Production, London). pp 7-12 of Operation of instruments in adverse environments, 1976. Knight, J. (ed.). London; Institute of Physics (1977).

From Conference on the operation of instruments in adverse environments; London, UK (4 Oct 1976).

See CONF-7610120—.

Shell UK Exploration Production commenced production from the North Sea in 1968, and now have six production platforms and two compression platforms operational in the Southern gas fields; one oil production platform operational in the Central area of the Auk field, and six oil or oil-gas platforms in various stages of construction or installation in the Northern areas, the first of which is nearing operation. In the Southern areas the principal corrosion problems in instrument systems have been solved in general by selecting from equipment manufacturers alternative materials and finishes, coupled with careful installation procedures. On the more northerly installations process equipment is housed in enclosed modules; these, when operational, have forced ventilation and heating which results in a reasonable environment for the instruments. In the modules where hydrocarbons are processed or handled, instrument electrical equipment must meet IP zone 1 safety requirements. Shell practice has been to maximize use of pneumatic equipment; the increasing complexity and construction costs of the northern platforms will make distributive intelligence data highway type systems attractive when they have been proven in onshore operations. Developments occurring in the design of underwater well completions and underwater processing units will require a new generation of ultrareliable equipment to operate under 200 metres or more of seawater.

25749 Offshore platform NDT instrumentation requirements. Peters, V.A. (Unit Inspection Co., Swansea, Eng.). pp 13-18 of Operation of instruments in adverse environments, 1976. Knight, J. (ed.). London; Institute of Physics (1977).

From Conference on the operation of instruments in adverse environments; London, UK (4 Oct 1976).

See CONF-7610120—.

The difficulties that have been experienced in applying standard dry-land non-destructive test methods using ultrasonics, eddy current, magnetic particle, and radiographic instrumentation in the inspection of fixed oil and gas production platforms in the North Sea are discussed. Some details are provided of the attempts that have been made to overcome the problems of using essentially dry-land equipment in the underwater environment, and an indication of the current thinking regarding the requirement for instrumentation development is given. A description of the work presently being undertaken by the author's company in developing a continuous monitoring system for monitoring the North Sea structures for fatigue cracking using acoustic emission techniques is given.

25750 Numerical method of determination of hydrodynamic conductibility of a nonhomogeneous oil-bearing stratum. Golubev, G.V. (Kazan' Avitat Inst im. A.N. Tupolev, USSR). *Izv. Vyssh. Uchebn. Zaved., Neft Gaz;* No. 5, 62-66(1977). (In Russian).

Determination of hydrodynamic conductibility Δ in a nonhomogeneous oil-bearing stratum, with plane filtration of an incompressible fluid, is reduced to a Cauchy problem for a first-order partial differential equation. It is proposed to solve the problem by the finite difference method. Some implicit difference analogs of the noted equation, as well as of a modified one, are constructed. Stability of the reduced difference schemes is investigated. The difficulties arising in this respect are discussed. The results of computer-aided calculations are set forth. At each stratum, the system of difference equations is solved by the runover method. Calculations are carried out in accordance with programs composed in ALGOL. The results are evaluated as acceptable.

25751 M6 steam drive project design and implementation. Herrera, A.J. *J. Can. Pet. Technol.;* **16**: No. 3, 62-71(1977).

The M-6 steam drive project is located in the Tia Juana field, Bolivar Coast, Venezuela and is scheduled to go on stream toward the end of 1977. The past performance and the prediction of future performance are discussed on the basis of the results obtained from an earlier, smaller scale steam drive project, laboratory investigations on physical models and compaction drive theory. In three inverted seven spots steam is being injected continuously, the first hexagon started in November 1975 and the other two in July and August 1976. Tracers in the gaseous and aqueous phase were inject-

ed to detect preferential flow. The results of these tests are discussed. 9 refs.

25752 Pressure drop and flow distribution of a polymer solution in a non-homogeneous porous medium. Vossoughi, S.; Seyer, F.A. (Univ of Alberta, Edmonton). *J. Can. Pet. Technol.;* **16**: No. 3, 110-115(1977).

In oil displacement from porous media by dilute polymer solutions, oil recoveries ar often much higher than with conventional water floods. In this study, the porous medium consisted of rows of glass rods similar to those used in earlier studies, but with nonuniform spacing of the rods. Using both polymer solutions and Newtonian fluids, flow distributions were measured in individual pores with streak photographs taken through a microscope. A simple parallel-plate capillary model for the bed was sufficient to interpret all of the Newtonian data, including the effect of pore size on flow rate through the pore. The polymer solution is expected to inhibit dispersion and also reduce the tendency for viscous fingers to form in large pores, which in turn may be one of the major effects in enhancing recovery. 24 refs.

25753 Multifactor mathematical models of the core drilling-out process by lateral drilling core catchers. Shtur, V.B.; Filimonov, N.M.; Mavlyutov, M.R. (Ufa Pet Inst, USSR). *Izv. Vyssh. Uchebn. Zaved., Neft Gaz;* No. 5, 11-14(1977). (In Russian).

Results of a laboratory research into the process of core drilling-out by diamond and hard-alloy bits of drilling core catchers under bottom-hole similating conditions are presented. Study of the derived multi-factor mathematical models of the core drilling-out process made it possible to obtain an overall picture of the investigated process and to reveal the extent of the effect of each investigated factor or the output parameters of the process.

25754 Spiral deformation of a pipe string in a directional well. Yanturin, A.Sh.; Sultanov, B.Z. (Ufa Pet Inst, USSR). *Izv. Vyssh. Uchebn. Zaved., Neft Gaz;* No. 5, 15-20(1977). (In Russian).

The problem of spiral deformation of a drill pipe string is solved taking into account the friction of joints against the walls of the directional well. Formulas are presented for the determination of the bending moment of the shearing force, the pitch of the spiral, and the force of pressure against the hole wall in an arbitrary cross section of the pipe string. A method of determination of the axial load transmitted to the bottom hole from the weight of the pipe string is proposed. Analytical relations are obtained, characterizing the longitudinal compressing load, the torque, and the spiral pitch, corresponding to the upper boundary of spiral deformation of a pipe string as a function of the borehole zenith angle.

25755 Problem of stability of drill pipe strings. Kadirov, N.B. (Az SSR Polytech Inst im. Ch. Il'dryma). *Izv. Vyssh. Uchebn. Zaved., Neft Gaz;* No. 5, 21-25(1977). (In Russian).

Stability of a drill pipe string under the effect of static and dynamic loads during the process of oil well drilling is considered. The critical length of the unstable part of a drill pipe string is found. Using the proposed method, it is possible to determine the laws of variation of the critical length of a drill pipe string, depending on its design and operating parameters.

25756 Suction sticking of drilling tools. Bernadiner, M.G.; Izmailov, T.Z. (Az SSR Inst of Pet and Chem im. M. Azizbekov). *Izv. Vyssh. Uchebn. Zaved., Neft Gaz;* No. 5, 26-28(1977). (In Russian).

Based on the consideration of the mechanism of the phenomenon of suction sticking of drilling tools, a formula is derived for the evaluation of the force required to separate a suction-stuck drilling tool. It is shown that this force is considerable and that it must be taken into account when trying to free the stuck tool.

25757 Investigation of the cake formation process under static filtration conditions. Angelopulo, O.K.; Kalinevich, G.E.; Podgornov, V.M. (Moscow Inst of Petrochem and Gaz Ind im. I.M. Gubkin, USSR). *Izv. Vyssh. Uchebn. Zaved., Neft Gaz;* No. 5, 29-31(1977). (In Russian).

Results of investigation of the kinetics of static filtration at the initial moments of the process are presented. It is found that formation of the filtration cake takes place depending on initial velocity of filtration. One of the ways to control the cake formation process is the use of solutions with an optimum concentration of the solid phase.

25758 Experimental investigation of the displacement of uniform mixing nonnewtonian systems. Peisakhov, S.I.; El'darov, T.R. (Az SSR Inst of Pet and Chem im. M. Azizbekov). *Izv. Vyssh. Uchebn. Zaved., Neft Gaz;* No. 5, 38-42(1977). (In Russian).

Based on experimental investigations concerning the displacement of uniform mixing nonnewtonian systems in a flat and a circular pipe, it is shown that the completeness of displacement becomes stabilized with increasing pressure gradient. It is also found experimentally that, for certain values of the ratio between the shear stress and the corresponding value of structural viscosity, the completeness of displacement reaches its maximum.

25759 Determination of leakage of a liquid obeying an exponential model, in the piston-cylinder gap of a deep pump. Kasimova, Sh.S.; Dadash-Zade, M.A.; Aliev, E.A. (Az SSR Inst of Pet and Chem im. M. Azizbekov). *Izv. Vyssh. Uchebn. Zaved., Neft Gaz;* No. 5, 67-69(1977). (In Russian).

The leakage of a liquid which obeys an exponential model, in an annular gap in steady flow past a cylindrical body situated in a vertical pipe string, is considered. The velocity of the mobile piston is taken into account. In accordance with the expression obtained, leakages are calculated for the pumps used at Azerbaijanian deposits, taking account of different factors, such as the height of the liquid column, radius of piston, thickness of the gap, length of piston, velocity of the liquid, etc.

25760 Self-alignment in thrust bearings. Nasibov, N.A. (Az SSR Polytech Inst im. Ch. Il'dryma). *Izv. Vyssh. Uchebn. Zaved., Neft Gaz;* No. 5, 98-102(1977). (In Russian).

Problems of self-alignment of spherical bearing discs (rings) of thrust bearings are considered. It is shown that the main factor preventing self-alignment is jamming of the spherical disk in its support. Relations are derived which describe this phenomenon. The jamming friction coefficient, a criterion proposed earlier, is used for quantitative evaluations. The relations obtained may be used in designing self-aligning (ball-and-socket) thrust bearings.

25761 Submarine transports offshore workers below the surface. *Eng. J. (Montreal);* **60**: No. 4, 12(1977).

The Taurus A minisub can carry divers to the seabed and pass them in and out of the vehicle while supplying breathing mixtures and electric or hydraulic power services. The prime purpose of Taurus, however, is transport of oilfield maintenance crews down to seabed located 'habitats' or chambers housing petroleum equipment. This equipment comprises either individual wellheads or manifold centers controlling five or six wells. Several of these chambers have been installed in the Gulf of Mexico and others are projected for the North Sea and offshore areas of Brazil.

25762 Percolation through clay crusts. Kochina, I.N.; Mikhailov, N.N. *Fluid Dyn. (USSR) (Engl. Transl.);* **11**: No. 6, 879-883(1976).

Experimental data are used which show that the permeability and compressibility of the clay crust depend on the stresses acting in the particles of the clay crust. The problem is reduced to a self-similar problem. An ordinary differential equation of the second order is derived for the function in terms of which the stress and characteristics of the crust are expressed. The distributions of permeability and porosity over the thickness of the crust are found and the quantity of fluid that penetrated into the bed at each instant is also determined. 12 refs.

25763 Geologo-technical efficiency of rising thermometry and radioisotopes in investigation of pumping wells in Tataria. Tsvetov, V.V.; Srebrodol'skii, D.M.; Khajretdinov, R.Sh. *Neftegazov. Geol. Geofiz.;* No. 11, 32-35(1975). (In Russian).

The use of radioactive isotopes and thermometry for evaluating the tightness of the cement ring below the perforated strata in the forced wells of the petroleum fields in Tartaria is described. The measurements were made with dual channel equipment (gamma logging and thermometry); the electrothermometer was of the resistance type, model EhTS; the error in temperature determination was +- 0.5C.

PROCESSING

REFER ALSO TO CITATION(S) 25788, 25789, 25794, 25815, 25820

25764 (NP—22646) Hydrocarbon cracking on amorphous and zeolithic cracking catalysts. Geertsema, A. (Karlsruhe Univ. (TH) (Germany, F.R.). Fakultaet fuer Chemieingenieurwesen). 5 Jul 1976. 162p. (In German). Dep. NTIS (US Sales Only), PC A08/MF A01. Thesis.

The catalytic cracking of n-dodecane, trans-decalin, and a dodecane-decalin mixture was studied in a fixed-bed reactor using an amorphous and a zeolithic catalyst. Studies on the influence of temperature and space velocity in dependence of the duration of the experiment were carried out in order to investigate the reaction process and the connection between coking, and selectivity changes in the two catalysts. A special sampling technique was developed to study selectivity changes in the product flow during catalyst deactivation due to coking. A quantitative analysis of the fission products from methane to dodecane was made possible by capillary chromatography with a suitable temperature program starting at -8°C.

25765 Adances in petrochemical technology. (Inst of Chem Eng, Rugby, Engl). *Inst. Chem. Eng. Symp. Ser.;* No. 50, vp(11 May 1977).

This symposium of 16 papers covers the following topics: economics of naphtha versus gas cracking; manufacture of HDPE by the Union Carbide gas phase process; stress corrosion cracking of steel in ammonia; polyvinyl chloride--effects of the vinyl chloride health problem; hazards associated with the use of austenitic stainless steels in process plants; vapor compression cycle for separation of close boiling components by distillation; immobilized isomerase in reaction columns; low energy phthalic anhydride production route and maleic anhydride production route and maleic anhydride recovery processes; advanced technology in cloride caustic soda production plants. Selected articles are indexed separately.

25766 Some recent trends and advances in petrochemical technology. Hibbs, F.M.; Pollitzer, E.L. (UOP Process Int, Inc, London, Engl). *Inst. Chem. Eng. Symp. Ser.;* No. 50, 1-8(11 May 1977).

North Sea crude will be supplying an appreciable fraction of the West European petroleum requirement by 1985. Despite this, a shortage of light feedstocks seems likely, particularly if petrochemical growth outstrips crude demand. A substantial growth in fluid catalytic cracking and hydrocracking is therefore expected and recent advances in these and several downstream areas of technology are described. Particularly significant advances include the development of a continuous regeneration process and improved catalysts for catalytic reforming, the direct production of acrylonitrile and other products from olefins, the UOP Sorbex separation scheme and its several different applications such as the efficient processing of C$sub 8$ aromatics streams.

25767 Developments in olefins production technology. Solomon, S.M. (C-E Lummus, Bloomfield, NJ). *Inst. Chem. Eng. Symp. Ser.;* No. 50, 99-120(11 May 1977).

The major forces influencing new developments in olefins production technology have been rising costs of feedstocks and energy, uncertainties in feedstocks supplies, and greater availability of heavier feedstocks. The technology developments which have been evolving as a consequence of these trends are: (a)High-selectivity/high-capacity pyrolysis modules with full feedstock flexibility. (b) Significantly reduced recovery section energy requirements. (c) Feedstock pretreatment techniques which enhance the product spectrum of less desirable feeds. The bases and implications of these developments are reviewed.

25768 Corrosion control in gas processing plants which remove CO_2 and H_2S. Martin, C.W.; Asperger, R.G.; Davidson, J.R.; Pearce, R.L. *Energy Process./Can.;* **70**: No. 1, 52-56, 58(1977).

Until now, the use of high monoethanolamine concentrations for H_2S and CO_2 mixed gas service has been limited by corrosion problems. It has been shown in the laboratory, pilot plant and field plants, that high amine concentrations can be used if good corrosion control is utilized. Considerable energy savings can be achieved by operating units at 30% MEA instead of 15 to 20%. If the gas being removed is mostly H_2S, it is theoretically possible to run existing or grass-roots plants at even higher amine concentrations which is limited primarily by the heat of reaction liberated in the absorber. Corrosion at high amine concentrations should no longer be the limiting factor in saving energy or expanding capacity for existing MEA units.

25769 Combined process of partial deparaffination and de-oiling of solid hydrocarbons. Ol'kov, P.L.; Panarina, A.S.; Vasil'eva, T.N.; Sevnitskaya, N.I. (Ufa Pet Inst, USSR). *Izv. Vyssh. Uchebn. Zaved., Neft Gaz;* No. 5, 47-49(1977). (In Russian).

The dependence of the depression of partly deparaffined oils on the depth of deparaffination is investigated. It is shown that under the conditions of two-stage deparaffination of the refining product, corresponding to the de-oiling conditions (t=-5°C, t=0°C), partly deparaffined oil with the solidifcation temperature of +3°C and paraffin with up to 1.5% content of oil are obtained. When the AZNII-TsTATIM-1 additive is added to the partly deparaffined oil, oil with the solidification temperatures of -23°C is obtained.

25770 Improvement of some properties of diesel fuel distillates. Sitaraman, P.D.; Shikhalizade, P.D.; Yusufzade, A.A. (Az SSR Inst of Pet and Chem im. M. Azizbekov). *Izv. Vyssh. Uchebn. Zaved., Neft Gaz;* No. 5, 50-52(1977). (In Russian).

Qualities of 20° fractions of diesel fuel distillate obtained by direct distillation are presented. The possiblity of selective batch purification of the 260-360°C fraction by means of dimethylformamide is shown. The purified fraction was compounded with the remaining ones; the compound obtained met all the requirements of the Soviet state standard GOST 4749-73.

25771 Influence of feedstock distillation range on hydrocarbon conversion and changes in luminometer number upon dearomatization of distillates from Nizhnevartovsk crude oil. Radchenko, E.D.; Khavkin, V.A.; Likhterova, N.M.; Rogov, S.P.; Agafonov, A.V.; Gryaznov, A.P.; Petrov, B.P.; Polyakova, A.A.; Osipov, L.N. (All-Union Sci-Res Inst for Pet Process, USSR). *Chem. Technol. Fuels Oils (USSR) (Engl. Transl.);* **13**: No. 1/2, 15-17(1977).

It is demonstrated that the use of effective hydrogenation catalysts makes it possible to dearomatize sulfur-containing kerosine distillates at relatively low pressures, on the order of 50 kg/cm². The process of catalytic hydrogenation is of considerable interest in producing fuels for gas-turbine engines from crude oils with high contents of aromatic hydrocarbons. Nizhnevartovsk crude oil is a promising material for the production of gas-turbine fuels, but it is impossible to obtain fuel with less than 20% aromatic hydrocarbons from this crude by the use of conventional hydrotreating processes. Results of an experimental study are presented and evaluated. It is shown that by hydrogenation of the cuts from Nizhnevartovsk crude oil, one must take note of the substantially lower conversions of aromatic hydrocarbons in the heavier cuts. The governing factors here are both the higher molecular weight of the heavier feedstocks and the high contents of sulfur, nitrogen, and other components that deactivate the catalyst. 4 refs.

25772 Catalytic reforming of naphtha cuts over polymetallic catalysts. Maslyanskii, G.N.; Zharkov, B.B.; Fedorov, A.P.; Klimenko, T.M.; Shapiro, P.N.; Pannikova, R.F. (All-Union Sci-Res Inst of Pet Process, USSR). *Chem. Technol. Fuels Oils (USSR) (Engl. Transl.);* **13**: No. 1/2, 18-23(1977).

This paper reports on recent developments in catalytic reforming of petroleum products, particularly on naphthas. The main trend in the evolution of the catalytic reforming process for naphthas is maximum involvement of paraffinic hydrocarbons in the aromatization reaction and improvement of the process selectivity. Success in solving these problems has led to a considerable increase in yields of the desired products (reformate, aromatic hydrocarbons) and to a further increase in the octane number of the reformer gasoline. These improvements in the catalytic reforming process have involved both changes in the composition and properties of the catalysts that are used (Table 1) and changes in the process technology. Experimental results obtained with various multimetal catalysts under different technological conditions are tabulated and discussed. Several catalysts developed in U.S.S.R. are evaluated in terms of their performances. 12 refs.

25773 Optimal conditions for selective hydrocracking of raffinates. Tsybulevskii, A.M.; Gorechenkova, N.A.; Kovalenko, V.K.; Pak, P.M.; Zhurba, L.A.; Dubinskaya, V.Ya.; Savv, K.R. (All-Union Sci-Res and Des Inst for Gas Process, USSR). *Chem. Technol. Fuels Oils (USSR) (Engl. Transl.);* **13**: No. 1/2, 23-26(1977).

The work reported was devoted to a search for the optimal conditions in the selective hydrocracking of raffinates. In order to determine the process conditions for maximum yield and high selectivity with respect to gasoline, an orthogonal experiment design was used. In the reported study, computer was employed to elucidate the optimal process conditions. Results are presented which show that the optimal process characteristics are achieved at high pressure, either in the region of low temperature with low productivity of the catalyst, or in the region of high temperatures with high productivity of the catalyst. With these two possibilities, the problem of optimizing selective hydrocracking can be resolved by selecting criteria that are technoeconomic in character. 6 refs.

25774 Effect of catalytic cracking method in product yields. Rustamov, M.I.; Aliev, V.S.; Pryanikov, E.I.; Abdullaev, M.A. *Chem. Technol. Fuels Oils (USSR) (Engl. Transl.);* **13**: No. 1/2, 26-30(1977).

In catalytic cracking, the process indices depend to a considerable degree on the method used for cracking the recycle. The recycle may either be cracked together with fresh feed in a single reactor or separately in an independent vessel. In the second case, the recycle cracking can be conducted under optimal conditions, and the effect of recycle on the fresh-feed cracking process is eliminated. In the separate cracking of fresh feed and recycle, the yield of products in Stage II (recycle cracking) depends on the quality of the recycle, which in turn depends on the severity of the Stage I process (fresh-feed cracking) and the method of taking off the reaction products from the corresponding reactors. Results of an experimental investigation are presented which show that, of the three variants of catalytic cracking that have been examined, the most efficient is two-stage catalytic cracking with separate cracking of fresh feed and recycle and separate takeoff of the reaction products from Stage I and II (two-tower scheme). Somewhat poorer process indices are obtained when two-stage cracking is used with separate cracking of fresh feed and recycle and common takeoff of the reaction product(one-tower scheme). The least efficient is the scheme in which the fresh feed and recycle are cracked jointly in a single stage.

25775 Use of a third-order Latin square in selecting hydrocracking catalysts. Kadyrova, G.I.; Yanichkin, L.P.; Abidova, M.F. (Cent Asian Sci-Res Inst for Pet Process, USSR). *Chem. Technol. Fuels Oils (USSR) (Engl. Transl.);* **13**: No. 1/2, 31-32(1977).

The present work represents an attempt to use a 4*4 hyper-Graeco-Latin square in selecting catalysts. As is well known, third-order Latin designs are extremely economical with respect to the number of experiments, and are normally recommended for the

initial stage of investigation: i.e., in screening tests aimed at revealing promising combinations of levels of the factors being varied. In the reported study, the authors were concerned with obtaining a preliminary evaluation of the effectiveness of four catalytic systems (Factor C) in the process of hydrocracking a vacuum gas oil from Arlan crude, as well as the promising effect of four Group I elements (Factor B) and four Group II elements (Factor A). The following indices of the process were evaluated--y_1, the depth of conversion or the yield of liquid product, in % by weight; y_2, the total yield of fuel fractions, in % by weight; y_3, the yield of diesel fuel cut, in % by weight; y_4, the degree of desulfurization of the liquid product, in %; y_5 and y_6 are the respective residual contents of sulfur in the diesel and naphtha cuts, in % by weight; y_7 is the solid point of the diesel fuel cut, in °C; and y_8 is the degree of dearomatization of the liquid products, in %. 2 refs.

25776 Polymerization (oligomerization) of isobutyl from eneommercial c_4 hydrocarbon fraction in the presence of soluble organoaluminum catalysts. Minsker, K.S.; Kirillov, A.P.; Sangalov, Yu.A.; Yudaev, A.I.; Yanu, A.Yu.; Plisov, A.V. (Inst of Chem, Bashk Branch, Acad of Sci of the USSR). *Chem. Technol. Fuels Oils (USSR) (Engl. Transl.);* **13**: No. 1/2, 33-37(1977).

Commercial fractions of C_4 hydrocarbons are byproducts in petrochemical manufacture; after recovery of the butadiene, the remainder is not always used profitably. Any practical utilization of such a C_4 fraction must be predicated on separation of the material into individual components. For example, isobutylene to be used in the synthesis of polymeric products must not contain any n-butylenes or butadiene. However, neither superfractionation nor any one of numerous chemical methods for recovery isobutylene can serve as a reliable, convenient, low-cost method for the production of polymerization-grade isobutylene. This paper presents results of a study in which an attempt has been made to polymerize (oligomerize) isobutylene without segregating it from the C_4 fraction; emphasis has been placed on the selection of organoaluminum catalysts. Results are presented which show that it is possible not only to resolve the problem of manufacturing commercial polymers and oligomers of isobutylenes, but also to open up new possibilities for the joint utilization of all components of the fraction. The method is based on the catalytic polymerization of isobutylene from the C_4 fraction in the presence of soluble organoaluminum halides. 14 refs.

25777 Efficiency of crude oil desalting in horizontal electrodehydrators. Isaev, V.N.; Sych, Yu.I.; Pinkovskii, Ya.I.; Bergshtein, N.V.; Khutoryanskii, F.I.; Gershuni, S.Sh. *Chem. Technol. Fuels Oils (USSR) (Engl. Transl.);* **13**: No. 1/2, 82-83(1977).

In recent years, the petroleum refineries of the Soviet Union have achieved major advances in the pretreatment of the crude oils supplied for processing. A major factor here has been the commercial introduction of USSR-manufactured horizontal electrodehydrators, as all large units for primary crude oil processing are equipped with such electrodehydrators. In this paper the authors present results from an operating test on 2EG150 horizontal electrodehydrators in a high-capacity unit at the Ryazan' Petroleum Refinery. It is demonstrated that crude oil containing on the average about 1% water and 1870 mg/liter salts was successfully desalted in two stages to a residual salt content of 5 mg/liter and a residual water content of 0.14%.

25778 Commercialization of new technology for two-stage cascade-countercurrent catalytic cracking. Melik-Akhnazarov, T.Kh.; Basov, V.A.; Agafonov, A.V.; Kogan, Yu.S.; Livshits, R.S.; Stankevich, V.A.; Chernakova, G.N.; Zeinalov, F.I.; Ishkhanov, G.S.; Shlyakhovskii, I.D.; Guseinov, E.A. (All-Union Sci-Res Inst for Pet Process, USSR). *Chem. Technol. Fuels Oils (USSR) (Engl. Transl.);* **13**: No. 1/2, 84-87(1977).

The paper describes a new process technology which has been developed for two-stage cascade-countercurrent catalytic cracking, as well as a design for a combined sectionalized reactor. The development of the system was preceded by experimental confirmation of the feasibility of using a sectionalized fluid bed to intensify heterogeneous processes of alkylation, oxidative regeneration of adsorbents and catalysts, catalytic dehydrogenation of butane, etc. The essential feature of the new technology is that the reaction products after the first stage of the process (cocurrent flow) are separated from the catalyst and pass to the second stage of the process. In a counterflow a second stream of freshly regenerated circulating catalyst in a sectionalized fluid bed, further conversion of the feedstock takes place, along with establishment of the final product quality. Results of an operating test are given in which amorphous aluminosilicate microbead catalyst was used. Advantages of the system are outlined. 3 refs.

25779 Influence of alcohols on urea-adduct formation with solid paraffins. Gundyrev, A.A.; Kazakova, L.P.; Karaibog, M.V. (I.M. Gubkin Moscow Inst of the Petrochem and Gas Ind, USSR). *Chem. Technol. Fuels Oils (USSR) (Engl. Transl.);* **13**: No. 1/2, 101-104(1977).

One of the prospective methods for obtaining solid paraffins is the process of urea-adduct formation, through which the solid paraffins can be recovered from petroleum stocks with high contents of n-alkanes. The activator in this process is usually methanol. This paper presents results of an experimental program in which the authors systematically have studied the influence of a series of normal alcohols, from methanol to n-nonanol, and also isopropanol, when used as activators in the process of urea adduct formation with solid paraffins. The starting material in this work was a slack wax produced by pressing a 275-480°C wax distillate from Dolina crude. The slack wax had a distillation ran of 313-475°C, melting point of 43.3°C, and an oil content of 17.4%. Extensive experimental data are tabulated and discussed. It is shown that with increasing alcohol molecular weight, the effectiveness as an activator decreases; and excess activator not only fails to give a positive effect, but even has an adverse effect on the process of adduct formation. 11 refs.

25780 Limits of existence of fluidized bed of solid particles in vessel with dual-flow grid. Ponomarev, G.S.; Donat, E.V. (Perm' Polytech Inst, USSR). *Chem. Technol. Fuels Oils (USSR) (Engl. Transl.);* **13**: No. 1/2, 124-126(1977).

For many processes that are carried out in a fluidized bed of solid particles, the range of existence of the fluidized bed is very important. The main parameters determining this range are the input rate of the granular material, the gas velocity, and the free-fall velocity of the solid particles. The relations among these parameters have been studied quite thoroughly in the case of fluidization on grids without any back-flow of solid particles, and have been correlated and generalized in the monographs. In this paper the authors present results from an investigation of how the above-listed parameters influence the limits of existence of a fluidized bed of solid particles. In contrast to the data reported they have examined this question for continuous feed of a granular material to a cylindrical vessel with a dual-flow grid made up of wedge-shaped elements. 10 refs.

PRODUCTS AND BY-PRODUCTS

REFER ALSO TO CITATION(S) 25766, 25767, 25769, 25770, 25771, 25772, 25773, 25774, 25776, 25779, 25818, 25819, 25820, 25831, 26543

25781 Investigations on Romashkino asphaltic bitumen. III. Fractionation of asphaltenes using ion-exchange chromatography. Boduszynski, M.; Chadha, B.R.; Szkuta-Pochopien, T. (Pol Akad Nauk, Gliwice). *Fuel;* **56**: No. 4, 432-436(Oct 1977).

The fractionation of asphaltenes originally separated from Romashkino asphaltic bitumen has been achieved by means of stepwise anion- and cation-exchange chromatography through macroreticular resins. The fractionation procedure and yields of the fractions are given. A detailed structural analysis has been made of original asphaltenes and their acid- and base-free fraction using elemental and densimetric analyses, gel-permeation chromatography and proton magnetic resonance spectroscopy. Results are presented to show the effect of ion-exchange resins treatment upon the composition of asphaltenes, noting that molecular weight as well as chemical structure changes appreciably. 22 refs.

25782 Design of a homogeneous reactor for the manufacture of chloromethanes. Cantu G, M. (Dir Gen de Pet, Mex). *Rev. Inst. Mex. Pet.;* **9**: No. 3, 68-77(Jul 1977). (In Spanish).

The kinetic model of methane chlorination reactions has been developed and applied to the study of a tubular methane chlorination reactor operating under either isothermal or adiabatic conditions. Computer programs for the design of such reactors have been written. 31 refs.

25783 Isomerization of n-pentane on group VIII metal/hydrogen-zeolite Y catalysts. Saito, M.; Iwasaki, T. (Natl Res Inst for Pollut and Resour, Kawaguchi, Saitama, Jpn). *Bull. Jpn. Pet. Inst.;* **19**: No. 1, 30-36(May 1977).

Catalytic activities of Group VIII metal/hydrogen-zeolite Y catalysts for isomerization and hydrogenolysis of n-pentane in the presence of hydrogen were investigated in a flow system at total pressure of 30 atm and temperatures from 270 to 320 C. The metal was introduced into the zeolite by ion-exchanging it with an aqueous solution containing the metal ion. Isomerization activity leveled off to a maximum at some metal content, whereas that of hydrogenolysis increased with increasing metal content with the exception of pd/Hy. The mechanism of isomerization of n-pentane is discussed on the basis of the experimental results. 16 refs.

25784 Studies on catalysts for low-temperature steam-reforming of hydrocarbons. IV. Kinetics of reaction on the Rh-$MgWO_4$ catalyst. Takami, K.; Igarashi, A. (Tohoku Univ, Sendai, Jpn). *Bull. Jpn. Pet. Inst.;* **19**: No. 1, 37-40(May 1977).

In order to clarify the main basic cause of the unique supporting property of $MgWO_4$, a kinetic study on the reaction between n-heptane and steam over a Rh-$MgWO_4$ catalyst was carried out at 500 C and 1 atm. It is shown that the initial rate experimentally obtained is best expressed by the rate equation. 15 refs.

25785 Steam reforming of hydrocarbons on alkali polyaluminate catalysts. II. Reactivity of deposited carbon. Kimura, T.; Nakabayashi, N.; Kubota, H.; Kikuchi, E.; Morita, Y. (Waseda Univ, Tokyo, Jpn). *Bull. Jpn. Pet. Inst.;* **19**: No. 1, 46-49(May 1977).

The reaction between steam and carbon deposited on potassium polyaluminate (β''-Al_2O_3) from various hydrocarbons was studied in a tubular flow reactor with a fixed catalyst bed at elevated temperatures. Carbon deposition from n-hexane took place above 600 C, while that from benzene required temperatures higher than 700 C. The reaction between steam and carbon deposited from both n-hexane and benzene, however, proceeded above 600 C. The lowest temperature required for steam reforming on β''-Al_2O_3 catalyst was decisively dependent on the ease of cracking of feed hydrocarbon to form carbon deposits. The reactivity of carbon with steam deposited from polyaromatic hydrocarbons was almost the same as that from benzene. On the other hand, carbon deposited from n-hexane or ethylene was somewhat less reactive than that from aromatics. 6 refs.

25786 Bayer process for the manufacture of maleic anhydride from butenes and as a by-product of the phthalic anhydride production. Heller, H.; Lenz, G.; Thiel, R. (Bayer, Werk Uerdingen, Ger). pp 121-128 of Advanced in petrochemical technology conference. Rugby, England; Inst. of Chemical Engineers (1977).

From Advanced in petrochemical technology conference; London, England (11 May 1977).

Maleic anhydride can be manufactured from two different sources by the Bayer-Process. The C^4-process is based on butene-butane mixtures as feedstock. Butenes are catalytically oxidized to maleic anhydride by atmospheric oxygen. Pure MA is recovered by azeotropic dehydration and vacuum distillation from the aqueous maleic acid solution obtained by scrubbing the oxidation gas mixture. The same dehydration and distillation procedure is utilized for the recovery of pure MA from phthalic anhydride plant effluent scrubbing solutions.

25787 Mechanism of action on rubber by products from thermal oxidation of hydrotreated fuels. Kovalev, G.I.; Nikonova, A.G.; Gogitidze, I.D.; Kuranova, V.I.; Chulyukina, A.V. *Chem. Technol. Fuels Oils (USSR) (Engl. Transl.);* **13**: No. 1-2, 64-68(1977).

It has been suggested that the source of accelerated aging of rubbers used in fuel pumps of gas-turbine engines operating on hydrotreated fuels is the oxygen-containing products formed in the fuel upon oxidation. It is well known that the process of hydrocarbon oxidation is accompanied by the formation of stable oxidation products (alcohols, carbonyl compounds, acids) and less stable products such as hydroperoxides or peroxides and free radicals. The present work was aimed at studying the effects of these oxidation products on Grade IRP-1078 rubber, which is used in fuel pumps, and was also aimed at using this information to develop measures to improve the properties of fuels relative to mechanical rubber goods. This study was carried out with the individual hydrocarbons cetane, cumene, and decalin, which are representative of the main hydrocarbon classes present in jet fuels; also used in this study were standard fuels differing in chemical composition. Extensive experimental data are tabulated and evaluated in terms of practical recommendations. These studies have shown that, in order to improve the service properties of hydrotreated and hydrogenated fuels with respect to rubbers, antioxidants that are acceptors of active radicals must be added to the fuels. This doping with antioxidant must be performed at the refinery itself, in order to eliminate the possible accumulation of peroxy compounds in the fuels during storage and transport. 2 refs.

25788 Increasing the efficiency of production of high. VI. Residual lube oils from Mangyshlak crude. Varshaver, E.M.; Vasserman, L.K.; Mitrofanov, M.G.; Pokusaeva, L.V. *Chem. Technol. Fuels Oils (USSR) (Engl. Transl.);* **13**: No. 1-2, 95-98(1977).

The high content of solid paraffins in residua from Mangyshlak crude (36-43% by weight) is responsible for rather high capital and operating costs in organizing the production of residual lubes from these stocks. Preliminary removal of part of the high-melting solid hydrocarbons and resins from the residuum represents an attractive approach to reduction of costs in the production of residual lubes. One of the methods to this end is treatment of the resid with dichloroethane in a 10/1 weight ratio of solvent to feedstock, at +15$degree$C. This results in the segregation of 68% (wt.) of an oil concentrate from the resid, for subsequent processing to manufacture residual lubes, and 31.7% (wt.) of a mixture of high-melting solid hydrocarbons and asphaltic/resinous substances, which has been named "ascerin". In this article, the authors compare the technoeconomic indices for the production of high-V.I. residual lubes by the conventional technology (Variant I) and by the technology involving pretreatment of the resid with dichloroethane (Variant II). The material streams in manufacturing high-V.I. residual lubes in accordance with these two variants are shown. Experimental technological data as well as cost accounting data are tabulated and evaluated. 3 refs.

25789 Influence of air input rate on oxidation of residuum in the presence of ferric chloride. Gun, R.B.; Pazhitnova, N.P.; Skopina, N.M.; Ivanyukov, D.V.; Kaminskii, E.F.; Shabalina, L.N. *Chem. Technol. Fuels Oils (USSR) (Engl. Transl.);* **13**: No. 1-2, 108-112(1977).

The air input rate has a substantial influence on the rate of the residuum-oxidation process and on the properties of the asphalts obtained. It has been established that higher air input rates accelerate the process of molecular condensation and make it possible to reduce the oxidation period. When the specific air input is increased up to a certain level, other conditions being equal, a proportional increase in the oxidation rate will be observed. Further acceleration of the oxidation process is achieved by the use of catalytic additives in the product being oxidized, with a simultaneous increase in the specific air input. This paper presents results from a study of the influence of specific air input on the rate of catalytic oxidation of a residuum, and on the behavior of the individual components of the residuum, the oxidation being conducted in the presence of 0.5% wt% ferric chloride. Extensive experimental data are tabulated and discussed in terms of technological recommendations. 5 refs.

25790 Main developmental tendencies in the high-volume, organic synthesis industry. Kalechits, I.V. *Zh. Vses. Khim. O-va. im. D. I. Mendeleeva;* **22**: No. 1, 3-7(1977). (In Russian).

This industry depends on oil as a raw material, and includes the production of ethylene, propylene, benzene, toluene, styrene, vinyl chloride, butadiene, ethyl alcohol, acetic acid, phenol, napthalene and other organics. It is pointed out that the production of plastics will increase from 29 million tons in 1970 to 80 to 100 million tons in 1980. The volume of production will double in 5 to 7 years in this industry. The rapid tempo of growth calls for a rapid replacement of industrial processes by other, more efficient processes, and also an increase in the unit size of the equipment. Thus there are plans to increase the equipment size from 500 thousand t/y to 1700 ton/y in pyrolyzing benzene to ethylene. Some attention will be paid to increasing the chemical reaction rate, to assembling large pieces of equipment from component parts, and to the selectivity of the chemical reaction. 2 tables, 28 refs. (SJR)

25791 Pyrolysis of petroleum fractions as the main source of raw material for the petrochemical industry. Mukhina, T.N.; Men'shchikov, V.A.; Barabanov, N.L.; . *Zh. Vses. Khim. O-va. im. D. I. Mendeleeva;* **22**: No. 1, 8-17(1977). (In Russian).

A review is presented on the technology of pyrolysis, kinetic models and on the construction of the main vessels such as the pyrolysis furnace and the evaporator unit. Information is also given on the outlook of further pyrolysis development. A look is taken at the effect of fractionation and group composition of the hydrocarbon raw material on the pyrolysis results. Information is given on material balances for the breakdown of the most readily available types of raw material. Technical details are presented on ethylene units which are flexible with regard to raw material. The effect of various pyrolysis parameters is shown such as temperature, reaction time, pressure, dilution with water vapor, etc. on the distribution of breakdown products. A determination of various criteria of severity in the pyrolysis process is given. The type of published literature on kinetic pyrolysis models is briefly summarized. Basic data are presented on the construction features of present-day, high-temperature, pyrolysis tube furnaces. Criteria characterizing the operation of various types of furnaces are compared, and the materials used in the tube furnaces are briefly presented. Significant attention is devoted to new prospective directions of developing pyrolysis technology. A brief look is taken at methods of pyrolyzing heavy petroleum products and raw oil. 3 figs., 6 tables, 68 refs. (SJR)

25792 Synthetic methods of using secondary pyrolysis by-products. Taber, A.M.; Livshits, B.R.; Zelentsova, N.I.; Avrekh, G.L. *Zh. Vses. Khim. O-va. im. D. I. Mendeleeva;* **22**: No. 1, 17-23(1977). (In Russian).

The chemical properties of allene, piperylene and methylacetylene are reviewed. These compounds are byproducts of pyrolysis processes formed in yields of about 1%. Polymeric allene is a white powder with a relatively high melting point and a high degree of unsaturation. It blends well with polyethylene in copolymer form. A number of various chemical compounds can be formed with these materials as raw materials. 45 refs. (SJR)

25793 Dehydrogenation of higher paraffins. Bursian, N.R.; Kogan, S.B.; Moroz, A.M. *Zh. Vses. Khim. O-va. im. D. I. Mendeleeva;* **22**: No. 1, 68-73(1977). (In Russian).

A report is given on the present state of studies in the field of dehydrogenating the higher linear paraffins in order to obtain the mono-olefins having 10 to 18 carbon atoms, which are used as raw materials for the production of biodegradable detergents. A look is

taken at the experimental data on the dehydrogenation of higher paraffins on oxide and platinum catalysts. The Rasol process developed by Universal Oil Products (U.S. firm) to produce higher monoolefins by dehydrogenation of the corresponding paraffins is presented for discussion as a commercial process. 5 figs., 5 tables, 40 refs. (SJR)

25794 Safety considerations for application of process stream analyzers in petrochemical plants. Barclay, A.G. (Shell Chemicals UK Ltd., Manchester, Eng.). pp 39-45 of Operation of instruments in adverse environments, 1976. Knight, J. (ed.). London; Institute of Physics (1977).

From Conference on the operation of instruments in adverse environments; London, UK (4 Oct 1976).

See CONF-7610120—.

The paper discusses safety considerations from the point of view of flammable atmospheres. Following a brief description of the function of process stream analyzers, the adverse environment in which they operate is defined as that created by flammable atmospheres and sources of ignition. The risk that these two conditions may exist simultaneously is considered to be the crux of the problem, and the arbitrary nature of the rules for defining degrees of hazard and codes of practice for protection are outlined. The installation of analyzers, either as individual field-mounted systems or grouped together in analyzer houses with a view to efficient and safe maintenance, is compared, and the remainder of the paper is devoted to the safety requirements for analyzer houses and their associated installations. These safety requirements are identified in the following areas: potential hazards, ventilation systems, safeguarding systems, installation design features and hazards associated with flammable material inside the analyzer itself.

25795 Oil and gas condensate from Luginets field. Smol'yaninova, N.M.; Stramkovskaya, K.K. *Chem. Technol. Fuels Oils (USSR) (Engl. Transl.);* **13**: No. 1-2, 79-82(1977).

This paper reports on an experimental program in which various products obtained by distillation of crude from one of Russian oil deposits were characterized and evaluated as useful fuels. Extensive test and analytical data are tabulated and discussed. These reported studies have shown that the straight-run distillates obtained from the crude oil and gas condensate of the Luginets field are identical in commercial quality. Hence, in developing and producing this field, it is desirable to organize joint transport of the condensate and oil; this will increase the potential content of light cuts and will improve the processing efficiency, whether fuels or petrochemicals are the final objective in the processing.

HEALTH AND SAFETY

REFER ALSO TO CITATION(S) 25722, 25802

25796 (AD-A—043843) **Full-scale aircraft crash tests of modified jet fuel. Final report, July 1972—May 1974.** Ahlers, R.H. (National Aviation Facilities Experimental Center, Atlantic City, N.J. (USA)). Jul 1977. 97p. (FAA-NA—77-35). NTIS PC A05/MF A01.

Crash tests were conducted with two A3 and two RB66 aircraft under impact-survivable crash conditions. The wing tanks in the first RB66 aircraft contained Jet A fuel modified with an 0.7-percent polymeric additive. The aircraft was crash tested into the specially constructed test site at 104.6 knots. The fuel mist generated by the fuel released from four crash-inflicted openings in the front wing spar was not ignited by the array of ignition sources. The wing tanks in the second RB66 aircraft were filled with JET A fuel modified with 0.5-percent of the same polymeric additive. The aircraft was crashed into the test site at 102.4 knots. The test conditions for the second RB66 test were made more severe by increasing the fuel temperature, partially drilling out areas in the front spar to increase the opened fuel spillage area, and by adding four fuel release openings under the wing, larger ignition sources, and operating the engines. The fuel mist burst into flame and followed the aircraft down the test site, continuing to burn until extinguished by the firefighting crew. These full-scale tests indicate that modified fuels have a potential for reducing the postcrash fire hazard and that small-scale tests should be conducted which are representative of full-scale crash conditions to determine the additive concentration to be used in any future crash tests. (Author)

MARKETING AND ECONOMICS

REFER ALSO TO CITATION(S) 25814

WASTE MANAGEMENT

REFER ALSO TO CITATION(S) 26571

25797 (NTIS/PS—77/0706) **Waste processing and pollution in the chemical and petrochemical industries. Volume 2. 1975—August 1977 1977 (a bibliography with abstracts). Report for 1975—August 1977.** Cavagnaro, D.M. (National Technical Information Service, Springfield, Va. (USA)). Aug 1977. 352p. NTIS PC N01/MF N01.

The bibliography includes control processes, emissions, economics, pollution effects, and abatement strategies relative to these industries. (This updated bibliography contains 347 abstracts, 188 of which are new entries to the previous edition.) See also NTIS/PS-76/0608, Waste Processing and Pollution in the Chemical and Petrochemical Industries. Vol. 1. 1964-1974.

ENVIRONMENTAL ASPECTS

REFER ALSO TO CITATION(S) 26905, 26924

25798 (AD-A—042375) **Biodegradation of oil in seawater for naval pollution control. Final report 1974—1976.** O'Neill, T.B. (Civil Engineering Lab. (Navy), Port Hueneme, Calif. (USA)). 1 Jul 1977. 12p. NTIS PC A02/MF A01.

The report describes the isolation and utilization of pure and mixed microbial cultures for experiments on the biodegradation of crude oil Bunker C fuel and marine diesel. Many microbial species were found that had hydrocarbonoclastic activity. When pure cultures were combined in mixtures the activity was much greater, 91% oxidation in seven days, than the activity of any one of the component species when used in a pure culture.

25799 (AD-A—046123) **OPC-3000 coalescing plate oil/water separator evaluation. Technical memo.** Mittleman, J. (Naval Coastal Systems Lab., Panama City, Fla. (USA)). Nov 1977. 62p. (NCSL-TM—212-77). NTIS PC A04/MF A01.

An oil/water separator for deballasting applications was designed and fabricated by Naval Coastal Systems Laboratory under Navy contract. Designated OPC-3000, the separator is in use at the Craney Island Fuel Depot, Portsmouth, Va. The separator's coalescing plate and foam design and system installation at CIFD are described. The results of performance evaluations between May and October 1977 are reported.

25800 (AD-A—046256) **Methods of identifying source of petroleum found in the marine environment. Report II. Final report 26 Jun 72—17 May 76.** Scolnick, M.E.; Scott, A.C.; Anbar, M. (Stanford Research Inst., Menlo Park, Calif. (USA)). Nov 1976. Contracts DOT-CG-81-74-1187;DOT-CG-22996-A. 94p. NTIS PC A05/MF A01.

The identification of oils by field ionization mass spectrometry is reported. Two multivariate data analysis models are described; a parametric statistical model that is based on the assumption of stochastic independence and an empirical model that can be used in a 'learning machine' mode. The results of applying the empirical model to 154 quadrupole spectra and 42 sector magnet spectra are reported.

25801 (EPA—600/9-77-019) **Alaskan oil transportation issues.** (Environmental Protection Agency, Washington, D.C. (USA)). Oct 1977. 15p. NTIS.

The tapping of the 9.6 billion barrel oil field on Alaska's North Slope required the development and implementation of numerous environmental safeguards before the 8 billion dollar, 800 mile, trans-Alaska pipeline could be built. The transport and distribution of this oil poses serious problems with respect to potential impacts upon the quality of air, water, and land, especially in the Western United States. Early in 1977, EPA prepared a summary of environmental issues associated with the movement of Alaskan oil. The report was prepared to acquaint administrators, scientists, and concerned citizens with the history and problems associated with assuring environmental compatibility in the disposition of Alaskan oil reserves. Highlights of that report are presented.

25802 (NP—22640) **Policies, practices, and responsibilities for safety and environmental protection in oil and gas operations on the Outer Continental Shelf.** (Geological Survey, Reston, Va. (USA)). Jun 1977. 28p. Survey, Reston, VA.

The Outer Continental Shelf Lands Act of 1953 designated the U.S. Department of the Interior to administer the mineral leasing of the off-shore areas of the U.S. under Federal jurisdiction. Within the Department, the U.S. Geological Survey was delegated the authority to regulate mineral operations on the Outer Continental Shelf (OCS). The overall policies, practices, and responsibilities of the Geological Survey to ensure oil and gas operations on the Outer Continental Shelf are conducted safely are summarized. The prac-

tices and concepts stated are the basis for developing, revising, and carrying out detailed procedures, plans, and other actions required for an effective regulatory program on the Outer Continental Shelf. The functional elements described contain provisions which are carried out on a nationwide basis or area basis in accordance with the requirements of the particular functional element. Those provisions requiring execution on an area-by-area basis are carried out in accordance with the stage of evolvement of each OCS Area. Thus, some elements may be completely functional in the Gulf of Mexico Area but may not be applicable in the OCS areas recently leased. Periodic reviews of this program are set forth to provide for implementing the provisions of the functional elements in each area as the operational activities warrant.

25803 (NTIS/PS—77/0750) **Oil spill removal techniques and equipment (a bibliography with abstracts). Report for 1965—September 1977.** Smith, M.F. (National Technical Information Service, Springfield, Va. (USA)). Sep 1977. 279p.

The removal processes cover oil water separators, skimmers, dispersants, adsorbents, flotation, and combustion. Related studies on oil spreading, droplet entrainment, prototype removal systems, equipment, and costs are also presented. Oil water separators designed only for tanker ballast water cleaning are excluded. (This updated bibliography contains 274 abstracts, 27 of which are new entries to the previous edition.)

25804 (NTIS/PS—77/1004) **Oil water separators (a bibliography with abstracts). Report for 1964-Nov 77.** Smith, M.F. (National Technical Information Service, Springfield, Va. (USA)). Nov 1977. 145p. NTIS PC N01/MF N01.

The citations cover Federally-sponsored research on these devices primarily for oil pollution control. Centrifuge separators, coalescers, filters, and skimmers are included. Oil recovery from oil spills and separation from ballast and bilge water are also cited. The operation, testing, and performance of this equipment in the laboratory and in the field are reported. (This updated bibliography contains 140 abstracts, 19 of which are new entries to the previous edition.)

25805 **Connector hinge for oil containment booms.** Campbell, F.J.; Graham, D.J. US Patent 4,016,726. 5 Apr 1977. Filed date 21 Aug 1975. 7p.

The patent describes a connector hinge for attaching oil spill containment booms to allow easy movement of connectors in both a vertical and horizontal direction. A resilient gasket is disposed within the male cylindrical connector such that the gasket forms an oil-tight seal between the male connector and female connector. The female connector is tapered along its length to allow easy disposition of the male member within its cylindrical cavity. Both the male and female connectors can be attached to a floating oil spill containment boom, a substantially immovable object such as a pier or jetty, or a floating tow assembly. The loose fit between the male and female connectors allows the connector hinge to adjust to tidal variations as well as additionally aiding in placement of the male connector within the female connector. The gasket material is formed of foam rubber, rubber, or any other suitable resilient material capable of forming an oil-tight seal. The gasket is formed in either a rectangular shape of beaded to aid in securing the gasket to the male connector.

POLICY, LEGISLATION, AND REGULATION

REFER ALSO TO CITATION(S) 26520

25806 (EMD—77-19) **Outer Continental Shelf Sale No. 35: problems selecting and evaluating land to lease.** (General Accounting Office, Washington, D.C. (USA)). 7 Mar 1977. 79p. Accounting Office, Washington, DC $1.00.

Report to the Congress by the Comptroller General of the United States.

Methods of tract selection and release evaluation procedures used in the Department of Interior lease of potential oil and gas tracts on the Southern California outer shelf are outlined. Errors in these procedures are noted, and it is recommended that the Department direct an exploration program to develop and implement a plan for appraising outer-shelf gas and oil resources. (JRD)

TRANSPORT, PIPELINES, AND HANDLING

REFER ALSO TO CITATION(S) 25801

25807 (NTIS/PS—77/0700) **Supertankers and superports (citations from the NTIS data base). Report for 1964—July 1977.** Habercom, G.E. Jr. (National Technical Information Service, Springfield, Va. (USA)). Aug 1977. 123p. NTIS PC N01/MF N01.

Construction and operation of supertankers and requirements for port facilities are reviewed in these Government-sponsored research reports. The environmental aspects are investigated. (This updated bibliography contains 118 abstracts, 21 of which are new entries to the previous edition.)

25808 (NTIS/PS—77/0701) **Supertankers and superports (citations from the Engineering Index data base). Report for 1970—July 1977.** Habercom, G.E. Jr. (National Technical Information Service, Springfield, Va. (USA)). Aug 1977. 113p. NTIS PC N01/MF N01.

Construction and operation of supertankers and requirements for port facilities are reviewed in these reports gathered from worldwide literature surveys. Environmental aspects, offshore mooring sites, and harbor preparation are among the features investigated. (This updated bibliography contains 106 abstracts, 31 of which are new entries to the previous edition.)

25809 **Noise of cargo oil pumps and effect on accommodation of large tanker.** Fukui, K.; Kunisada, N.; Hayashi, T.; Yokota, M.; Ito, Y.; Isozaki, M. *Kawasaki Giho;* No. 63, 100-106(Mar 1977). (In Japanese).

Recently, the noise problem of a ship at sea is being studied with good results by many people for the improvement in ship habitability. But few people have researched cargo oil pump noise and its effect on accommodation when unloading an oil tanker. To cope with such situation, at an official sea trial, we carried out the measurements of noise levels and acoustic vibration levels both the living spaces and cargo oil pump room. According to the results of the measurements, we could estimate where main noise sources are and how noises transmit from cargo oil pump room to accommodation when unloading the oil tanker.

25810 **Efficiency of hydraulic shipment of highly viscous oils in channels of rectangular cross section.** Markelov, S.S. (Tula Polytech Inst, USSR). *Izv. Vyssh. Uchebn. Zaved., Neft Gaz;* No. 5, 73-76(1977). (In Russian).

To increase throughput capacity of pressureless pipelines transporting highly viscous petroleum grades, hydraulic shipment is employed. This involves use of water as a layer underlying the lighter oil to reduce tangential stresses at the bottom of the channel. As a result of this investigation, it is found that, under laminar flow conditions, the efficiency of hydraulic shipment of highly viscous oils in open channels of rectangular cross section increases with an increase in oil viscosity and decreases with an increase in the flow depth. The optimum thickness of the underlying layer is found. It is a function of the ratio between viscosities. This thickness ensures maximum efficiency of hydraulic shipment of oil.

25811 **Economico-mathematical formulation of the problem of optimization of the construction of the linear part of oil pipelines.** Karpov, V.G. (Ufa Pet Inst, USSR). *Izv. Vyssh. Uchebn. Zaved., Neft Gaz;* No. 5, 103-106(1977). (In Russian).

In constructing an economonico-mathematical model of construction of the linear part of oil pipelines, it is proposed to use, as a criterion, the maximum national economic effect due to their commissioning ahead of schedule, taking into consideration additional expenditure of construction and assembly organizations to ensure it. Taking all this into consideration, a target function of the problem and constraints are determined.

PROPERTIES

REFER ALSO TO CITATION(S) 25781

25812 (AD-A—043566) **Review of diesel fuel deterioration and related problems. Interim report.** Stavinoha, L.L.; LePera, M.E. (Southwest Research Inst., San Antonio, Tex. (USA). Army Fuels and Lubricants Research Lab.). May 1977. Contract DAAG53-76-C-0003. 28p. (AFLRL—88). NTIS PC A03/MF A01.

This report represents in essence an 'overview' presented by the authors at a seminar sponsored by the U.S. Army Research Office (ARO) in April 1977 to promote basic research in the area of 'Diesel Fuel Stability'. This report provides a review of the general topic of fuel deterioration with primary emphasis on diesel or distillate fuels used in compression ignition engines which power the majority of Army tactical and combat vehicles. Selected field problems regarding fuel stability and related problems are presented and the status of on-going research and development programs are outlined. This information has been prepared to place in perspective the background and field problems which have prompted current research activities to detect, predict, and prevent fuel stability associated equipment failures. A selected bibliography used as the basis for the review portion of this report and as a source for additional fuel stability information has been provided. (Author)

25813 Electrolyte and pH effect on emulsion stability of water-in-petroleum oils. Oren, J.J.; MacKay, G.D.M. (NS Tech Coll, Halifax). *Fuel;* **56**: No. 4, 382-384(Oct 1977).

The stability of water-in-Guanipa crude emulsion was studied as a function of pH and the electrolyte concentration of mono- and polyvalent metal chlorides in the initial aqueous phase. The natural crude showed a medium to strong i.r. absorbance from silicon groups indicating that emulsion stability is supported by the oil content of dispersed mineral fines. Emulsion stability was found to be strongly dependent on pH of the initial aqueous phase. The results indicate that the electrolyte and pH affect the emulsion stability of water-in-petroleum oil through their action on the coagulation of the mineral colloids. The data point to the absorption of positive metal or negative hydroxyl ions on the gel. 18 refs.

25814 NEB veiw of development potential and markets for heavy crude oil. Scotland, W.A.; Gutek, A.M.H. (Natl Energy Board, Calgary, Alberta). *J. Can. Pet. Technol.;* **16**: No. 3, 103-109(Jul-Sep 1977).

Canadian heavy crude oil differs significantly from light crude oil in quality, refining characteristics, markets served and production circumstances. This paper is concerned only with the potential for conventional heavy oil supply and the prospects for heavy oil markets at home and abroad, as seen by the National Energy Board (NEB). The assessment of future conventional heavy oil supply is based on a detailed review of the potential for reserves growth. The largest potential for new heavy oil discoveries lies in Canada's Lloydminster area. 12 refs.

25815 Crude oils from new commercial fields in Belorussia. Egiazarov, Yu.G.; Smol'skii, A.M.; Agabekova, L.A.; Burak, Z.G.; Laburdova, E.V. (Inst of Phys and Org Chem, Acad of Sci of the B SSR). *Chem. Technol. Fuels Oils (USSR) (Engl. Transl.);* **13**: No. 1-2, 11-13(Jan-Feb 1977).

In this article, the authors present results from an investigation of crude oils from two new fields in Belorussia. The oil accumulations are confined to the Zadonsk-Elets (Well 7, Zolotukhino) and Voronezh (Well 95, Tishkovichi) carbonate deposits of the Upper Devonian. Certain physicochemical properties of these crude oils are listed in Table 1. It will be seen that the sulfur contents of the Zolotukhino and Tishkovichi crudes place them in the medium-sulfur category of GOST 912-66. In contents of resinous substances and wax, the Zolutukhino crude is classed as medium resin and high wax, the Tishkovichi crude as low resin and high wax. The contents of naphtha fractions distilling below 200°C are 22.1 and 26.0%, the total light fractions (below 350°C) 43.7 and 50.7%, respectively, for the Zolotukhino and Tishkovichi crudes. The naphtha cuts of these crude oils are low in knock resistance and in lead susceptibility. Characteristics of the residues obtained with different degrees of reduction are tabulated. The residues obtained after taking off the fractions distilling below 350°C are suitable for the production of Grade 100 boiler fuel.

25816 Determination of thermal stability of jet fuels under dynamic conditions. Gladkikh, V.A.; Sergein, E.P.; Sahevskii, V.V.; Ivanov, A.L.; Makarov, Yu.P. *Chem. Technol. Fuels Oils (USSR) (Engl. Transl.);* **13**: No. 1-2, 136-139(1977).

This paper critically analyzes existing standardized test procedures for the determination of thermal stability of jet fuels in U.S.S.R. and presents results of an experimental test program aimed at improvement of the best methods. It is concluded that in order to improve the reproducibility of results from determination of thermal stability under dynamic conditions in DTS-1 units, it is necessary to specify the following: (a) prefiltration of the test fuel through filters with a pore size of about 5 μm, instead of the GOST 12026-66 filter paper with a pore size greater than 40 μm; (b) strict definition of the site of installation of the thermocouple in the test filter housing, and reliable procedure checking the position of the hot junction; and (c) further monitoring of the thermal regime of the unit on the basis of readings of a thermocouple measuring the wall temperature of the test filter housing. 2 refs.

25817 Character of distribution of naphthene acids in petroleums of lower Kura depression deposits. Gadzhi-Kasumov, A.S.; Dzhavadova, R.A.; Alimuralov, Sh.E. (Az SSR Inst of Pet and Chem im. M. Azizbekov). *Izv. Vyssh. Uchebn. Zaved., Neft Gaz;* No. 5, 3-5(1977). (In Russian).

The regularities of naphthene acids distribution in the petroleums in question indicate that changes in naphthene acids in the petroleums of the Lower Kura Depression are analogous to those of petroleums of the Apsheron Pennisula deposits. It is concluded that increase in the content of naphthene acids in petroleums of the invidual deposits by height is related to gravitational stratification of petroleum of different composition.

25818 Density of liquid propylene on the curves of coexistence liquid--vapor, liquid--solid. Golovskii, E.A.; Tsymarnyi, V.A. (Odessa Inst of Eng of the Marit Fleet, Ukr SSR). *Izv. Vyssh. Uchebn. Zaved., Neft Gaz;* No. 5, 70-72(1977). (In Russian).

Density values, refined and harmonized with the liquid phase, of liquid propylene in the state of saturation are presented and the investigated temperature range is broadened up to the triple point. Results of an investigation of density on the curve of coexistence, liquid--solid, are presented. The values obtained are described analytically with a high degree of exactness and may be used to compile tables of standard reference data. 12 refs.

25819 Crude oils of the Georgian SSR. Tereshina, I.V.; Driatskaya, Z.V. *Chem. Technol. Fuels Oils (USSR) (Engl. Transl.);* **13**: No. 1-2, 14-15(1977).

A study has been made of the Georgian SSR (Gruziya) crude oil, consisting of a mixture of crudes from the Sangori, Norio, Mirzani, Supsa, and Chaladidi fields. Georgian crude is low sulfur, medium resin, and medium wax. The characteristics of this crude are tabulated. It is demonstrated that the hydrocarbon group composition of the fractions of Georgian crude distilling below 200°C is characterized by a predominance of paraffinic hydrocarbons (87-56%) over (0.0003%) (13-42%) and aromatics (0-14%). A study of the 28-150°C cut by gas-liquid chromatography showed that, out of the total quantity of paraffins in this cut (8.59% calculated on crude), the branched-chain paraffins account for 5.22% and n-paraffins for 3.37%. The branched-chain paraffins consist mainly of hydrocarbons with a single methyl group, such as 2-methylheptane (0.53%), 2-methylhexane (0.48%), and 3-methylhexane (0.40%). Of the straight-chain paraffins, the largest percentages are those of n-octane (1.10%) and n-heptane (0.95%). A kerosene cut was obtained in amount of 29.3% (calculated on crude), characterized by low contents of total sulfur (0.01%) and mercaptan sulfur (0.0003%) and rather high thermal stability. The Georgian crude cannot be recommended for asphalt production.

25820 Chemical composition of naphthas from coking of petroleum residues. Stekhun, A.I.; Ivanova, T.S.; Osipova, L.I.; Sumskaya, A.I. (Bashk Sci-Res Inst for Pet Process, USSR). *Chem. Technol. Fuels Oils (USSR) (Engl. Transl.);* **13**: No. 1-2, 88-94(1977).

In this paper the authors present results from a study of the individual hydrocarbon composition of the naphthas obtained by coking residue from West Siberian and Mangyshlak crudes. General characteristics of these naphthas are shown. The individual hydrocarbon composition of the coker naphthas was determined by a combination of the distillation and gas chromatography. First, the naphtha distillates were distilled in an efficient column, taking IBP-120°C and 120-180°C cuts. These relatively narrow cuts were then separated by preparative FIA (fluorescent-indicator-dadsorption) chromatography into paraffinic/naphthenic, olefinic, and aromatic groups of hydrocarbons, each of which was analyzed separately by GLC. Detailed analytical data are tabulated. 4 refs.

25821 Ozonolysis of asphaltenes. Filimonova, T.A.; Ertakova, L.D.; Eliseyev, V.S.; Kryazhev, Yu.G. (Inst. of Petroleum Chemistry, Moscow). *Pet. Chem. (USSR) (Engl. Transl.);* **16**: No. 3, 180-185(1976).

Translated from Neftekhimiya: 16: No. 5, 769-773(1976).

Petroleum asphaltenes were examined by ozonolysis. Low molecular weight carboxylic acids (acetic, propionic, butyric, oxalic, succinic and caproic) and a product of partially oxidized condensed aromatic structure with a system of conjugation were identified in the product of oxidation. From IR and PMR spectroscopy and elementary analysis of products of ozonolysis, it may be assumed that in asphaltenes nitrogen is mainly in the form of polycyclic aromatic structures and sulfur, in condensed aromatic systems.

STORAGE

25822 Application of automatic gas shield arc welding to the vertical butt joint of an oil storage tank shell. Matsuda, S.; Kuroiwa, F. *Kawasaki Giho;* **64**: No. 8, 76-83(Aug 1977). (In Japanese).

The automatic gas shield arc welding method used on the vertical butt joints of an oil storage tank was examined using quenched and tempered 60kg/mm² class high tensile strength steel with a thickness of from 10 to 45mm. The test results are summarized as follows: (1) Quantity of CO_2 in outer nozzle is 30 l/min. and that of Ar and CO_2 in inner nozzle is 25 l/min. Percentage of Ar is 80% and that of CO_2 is 20%. (2) Stable welding from one side is possible for vertical joints having a thickness of up to 30mm. Groove angle is 40 +- 5° and root gap is 5 +- 2mm. (3) All the mechanical properties of welding satisfied specified values.

25823 (UCRL-Trans—11314) **Use of gamma—gamma logging in the operation of underground reservoirs for gas and petroleum products in rock salt deposits.** Baembitov, F.G. Translated from *Tr., Vses. Nauchno-Issled. Inst. Yad. Geofiz. Geokhim.;* No. 7, 178-189(1969). 18p. Dep. NTIS, PC A02/MF A01.

For the purpose of systematically monitoring the conditions of reservoirs for the underground storage of gas and petroleum products in rock salt deposits, an integrated set of geophysical

investigations must be carried out during operation of the reservoirs to determine the shape of the chamber and the location of the gas and petroleum product-brine surface and of the chamber ceiling, to study the temperature, and to assess all possible leaks of gas and petroleum products. Radiometric measurements used in determining the petroleum product-brine surface are considered. In determining this surface by gamma-gamma logging, the coupling locator curve, from which the position of the casing shoe and couplings is determined, is recorded separately for correlation, and the location of the ceiling and petroleum product-brine surface are linked to it. This method of operation is used to make a special instrument for investigating underground reservoirs. A radiometer for underground reservoirs that simultaneously registers gamma-gamma and coupling locator logs has now been manufactured and placed in production. An integrated set of gamma-gamma logging and coupling locator measurements ensures reliable monitoring of the maximum filling of reservoirs during operation. It is advisable to carry out monitoring by the gamma-gamma logging method in graduating reservoirs and to use it in pumping the petroleum product into and out of the reservoir in order to determine the location of the contact surface. (JRD)

COMBUSTION

REFER ALSO TO CITATION(S) 25714, 25715, 26782

NATURAL GAS

25824 National gas survey. Volume 1. The Commission report. Washington, DC; Federal Power Commission (1975). 424p. (NP—23058). $4.65.

The survey is concerned with factors of demand, fuel sources, facility expansion, economic considerations, environmental considerations, import-export relations, and regulatory considerations. Results are presented in chapters on the resource and the industry, structure of the industry, regulation and legislation, gas shortages, total energy supply and demand, future gas demand, conservation, and future supplies. (JRD)

RESERVES

REFER ALSO TO CITATION(S) 25726

25825 Gas-condensate fields of the Taranaki basin, New Zealand. McBeath, D.M. (BP (Oil Exploration) Company of New Zealand Ltd., Wellington). *N.Z. J. Geol. Geophys.;* **20**: No. 1, 99-127(1977).

The onshore Kapuni and offshore Maui gas-condensate fields contain New Zealand's only proven hydrocarbon reserves. The fields lie within the Taranaki basin in the west of the North Island. Kapuni, discovered in 1959, first produced in May 1970. Maui, 40 km offshore in 360 ft (110 m) of water, discovered in 1969, is not due to produce until October 1978. Production from both fields is from Eocene sandstone reservoirs within the coal-bearing Kapuni Formation, which was deposited in a widespread coastal plain and fluviomarine environment. The original recoverable reserves of the Kapuni field are presently estimated at 460 million million Btu of dry gas (630 thousand million cu ft at 730 Btu/cu ft) and 34 million bbl of condensate. Production in 1973 averaged 46.3 million cf/d of gas (carbon dioxide content 43%) and 3500 b/d of condensate. With additional wells to be drilled in 1974, maximum deliverability will increase to 260 million cf/d of gas and 18,000 b/d of condensate so that 108.7 million million Btu (about 24% of the original reserve and two-thirds of the production) can be supplied as raw gas with its original carbon dioxide content to the New Plymouth power station during 1975-78 pending supply from Maui. Maui field reserves are estimated at 5730 million million Btu of dry gas (5590 thousand million cu ft at 1025 Btu/cu ft) with 161 million bbl of condensate and 51 million bbl of recoverable LPG. On production a maximum throughput of 750 million cf/d of gas and 20,000 b/d of condensate is envisaged. The gas will provide fuel for over 3000 megawatts of generating capacity in North Island power stations. Development of the field and associated processing and distribution facilities will be undertaken jointly by the Government(50%) and Shell, BP and Todd.

GEOLOGY AND EXPLORATION

REFER ALSO TO CITATION(S) 25688, 25727, 25728, 25729, 25730, 25731, 25734, 25735, 25737, 25738, 25739, 25742, 25744, 25859

25826 (CONF-771153—1) **Natural gas content of geopressured aquifers.** Randolph, P.L. (Institute of Gas Technology, Chicago, Ill. (USA)). 1977. 25p. of Gas Technology, Chicago, IL.

From 3. geopressured geothermal energy conference; Lafayette, LA, USA (16 Nov 1977).

It is hypothesized that free, but immobile, natural gas is trapped in pores in geopressured aquifers and that this gas becomes mobile as aquifer pressure is reduced by water production. Computer simulation reveals this hypothesis is a plausible explanation for the high gas/water ratio observed from the No. 1 sand in the Edna Delcambre No. 1 well. In this Delcambre well test, the gas/water ratio increased from the solution gas value of less than 20 scf/bbl to more than 50 scf/bbl during production of 32,000 barrels of water in 10 days. Bottom hole pressure was reduced from 10,846 to 9,905 psia. The computer simulation reveals that such increased gas production requires relative permeability to gas (k/sub rg/) increase from less than 10^{-4} to about 10^{-3} due to a decrease in fractional water saturation of pores (S/sub w/) of only about 0.001. Means for achieving these initial conditions during geological time are qualitatively discussed, and the effect of trapped gas upon long-term production is described.

25827 Ice platforms for offshore drilling. Masterson, D.M. (Fenco Consult Ltd, Calgary, Alberta). *Eng. J. (Montreal);* **60**: No. 4, 18-19(1977).

The method used most successfully and economically is the thickening of ocean ice to carry the weight of conventional land rigs. The use of the thick ice cover of the Arctic Islands as a load support permits exploratory drilling to proceed at reasonable cost without the development of ice resistant structures. To obtain the required ice thickness, natural ocean ice is thickened by successive flooding in thin layers with water pumped from beneath the ice. A system using electric submersible pumps in insulated wells which automates the flooding to a great extent is described.

25828 Geology and gas exploration potential, Upper Cretaceous and Lower Tertiary strata, northern Raton basin, Colorado. Dolly, E.D.; Meissner, F.F. (Filon Exploration Corp., Denver). pp 247-270 of Exploration frontiers of the central and southern Rockies. Veal, H.K. (ed.). Denver; Rocky Mountain Association of Geologists (1977).

From Symposium program RMAG fall field conference; Snowmass, CO, USA (29 Sep 1977).

See CONF-770972—.

Shallow gas accumulations are present in the Upper Cretaceous, Lower Tertiary section of the northern Raton basin. Gas-bearing reservoirs are found in lenticular, clayey, low-permeability sandstones deposited in a spectrum of continental, transitional and marine environments. The gas is apparently trapped in a complex series of overlapping and discontinuous channel sandstone units interbedded with water-bearing zones within the lower Poison Canyon, Raton and Vermejo Formations. A gas accumulation may also be present in a basin-bottom hydrodynamic trap within the Trinidad Sandstone. The gas is believed to be derived from the thermal alteration of bedded coals and coaly carbonaceous shales indigenous to the section. Zones which should be capable of production may be identified by modern mechanical-electrical logging and interpretational techniques. Attempts to produce gas commercially from these zones have been unsuccessful because of a variety of engineering problems related to subnormal formation pressures, low permeabilities and the susceptibility of montmorillonite clays in the sandstone reservoirs to damage from conventional drilling fluids.

25829 Estimation of carbonate reservoirs of East Turkmeniya from the lateral-logging and neutron-gamma logging data. Kerimov, T.G.; Katok, V.L. *Razved. Geofiz.;* No. 69, 129-131(1975). (In Russian).

A collection of data from three-electrode lateral logging and neutron-gamma logging is presented for solving problems of separating reservoirs in carbonate cuts and evaluating their gas content. Using actual material, the efficiency of the collection of data for solving these problems was demonstrated.

25830 Evaluation of porosity boundaries of reservoirs in Efremovskoye gas field. Omes, S.P.; Romanovskaya, N.S. *Neftegazov. Geol. Geofiz.;* No. 5, 29-31(1975). (In Russian).

A method for determining the porosity boundaries of reservoirs in the Efremovski gas field is described. A complex of industrial-geophysical studies, including temperature, flow rate, and radioactivity logging (gamma logging, neutron logging), was used. The data obtained were used for determining critical values of the reservoir properties and geophysical characteristics by which the gas-saturated strata are identified.

DRILLING, PRODUCTION, AND PROCESSING

REFER ALSO TO CITATION(S) 25748, 25749, 25762

25831 Economics of naphthe versus gas cracking. Chambers, L.E.; Singer, H. (Stone and Webster Eng Ltd, London, Engl). pp 9-25 of Advanced in petrochemical technology conference. Rugby, England; Inst. of Chemical Engineers (1977).

From Advanced in petrochemical technology conference; London, England (11 May 1977).

An evaluation has been made of North Sea derived natural gas liquids as a petrochemical feedstock for use on naphtha crackers. Preliminary fractionation into a C_2/C_3 and C_4^+ cut involves the minimal modification to an existing naphtha cracker. Profitability comparisons with more conventional feedstocks appear favorable. Provded the C_4^+ fraction is obtainable at a cost only slightly below that of naphtha, a R.O.I. is obtainable equivalent to that derivable from a "straight" naphtha cracker. A somewhat lesser R.O.I. is indicated for a purpose-built C_2/C_3 cracker. Feedstock costs are the dominant factor in the ethylene cost equation, followed by fuel and utilities and lastly by capital costs.

25832 Denitrogenation plant Clenze. Kaast, H.; Schlemm, F. (BEB, Hanover). pp 19p, Session II, Paper 6 of Fifth international conference on liquefied natural gas. Volume I. Chicago; Institute of Gas Technology (1977).

From 5. international conference on liquefied natural gas; Dusseldorf, F.R. Germany (29 Aug 1977).

See CONF-770879—P1.

In the newly developed East Hanover gas province, the consortium Preussag AG and Gewerkschaften Brigitta und Elwerath Betriebsfuhrungsgesellschaft mbH (BEB) discovered - apart from reservoirs with higher-calorific natural gas - a field at Wustrow near the GDR border, whose gas has a nitrogen content of 65 percent and cannot be marketed as such. Beginning at the end of 1974, therefore, plans were developed for a denitrogenation plant, which started trial operation in August 1976. As a suitable method for nitrogen separation, a low-temperature process was selected in which the methane is extracted in the liquid phase and then reconverted to the gas phase via evaporator. Since the natural gas contains also technically recoverable proportions of helium, initial plans provided for the installation of a helium recovery plant downstream of the denitrogenation plant. For economic reasons, however, these plans were not realized. The removal of undesired gas components and impurities in the natural gas, as CO_2, water, mercury and higher hydrocarbons, required special process technology and equipment. The operating personnel was familiarized without major difficulties with its new tasks, as BEB's proven and largely standardized monitoring and control system ensures a degree of automation which requires only a few manual interventions in the processes. Experiences made during test runs and initial operation and a detailed evaluation of all important process data, which are critical for a long-term trouble-free operation, resulted in favorable and encouraging tendencies, although after a relatively short time of operation.

25833 Beecher Island field, Yuma County, Colorado. Lockridge, J.P. (Mountain Petroleum, Denver). pp 271-279 of Exploration frontiers of the central and southern Rockies. Veal, H.K. (ed.). Denver; Rocky Mountain Association of Geologists (1977).

From Symposium program RMAG fall field conference; Snowmass, CO, USA (29 Sep 1977).

See CONF-770972—.

The Beecher Island field is located on a low relief anticlinal closure on the eastern flank of the Denver basin in Yuma County, Colorado. The field was discovered in 1919 but commercial development did not commence until 1972. Biogenic gas is produced from chalk with high porosity but low permeability at the top of the Smoky Hill Member of the Cretaceous Niobrara Formation at a depth of 1500 to 1800 feet. There are 21 gas wells, each on a 640 acre unit. Nineteen of these wells have been stimulated with a foam fracturing treatment and will deliver from 100 to 300 MCFGD. Cumulative production as of December 31, 1976 was 598,000 MCF.

PRODUCTS AND BY-PRODUCTS

REFER ALSO TO CITATION(S) 25843

25834 Relaxation of variable torque in the shafting for LPG compressors. Suzuki, K.; Watanabe, K.; Noguchi, K. *Kawasaki Giho;* No. 63, 88-93(Mar 1977). (In Japanese).

Reciprocating compressors produce a great variable torque at working. Using a motor shaft of propane compressor for LPG reliquefaction plant which had been fractured by fatigue, we calculated torque and vibration patterns theoretically and then measured them for actual values. As a result, we found unexpectedly large peak torque. To reduce peak torque, a flexible rubber coupling was fitted in the shafting. Then peak torque was reduced to a value about a quarter of the previous torque.

25835 Ownership transfer of LNG plants. Derrough, M. (SONATRACH, Algiers). pp 4p, Session III, Paper 3 of Fifth international conference on liquefied natural gas. Volume II. Chicago; Institute of Gas Technology (1977). (In French)

From 5. international conference on liquefied natural gas; Dusseldorf, F.R. Germany (29 Aug 1977).

See CONF-770879—P2.

The specific conditions leading to the transfer of property in the LNG plants suggest comment on the technical side rather than the legal one. The heavy investments supported by the producer for the whole liquefaction network (gas field to the consumer) plus the financial risks supported by the owner when the plant has just been put on stream make it unattractive for the owner. We wish therefore to imply the contractor more deeply in order to insure the owner; contractual production figures and quality of the products should be reached and normal operation controlled. This guaranty should go beyond contractual relations between owners and contractors and be applied for producer and consumer countries.

25836 Brunei liquefied natural gas plant. Ploum, A.J.W. (Brunei LNG Ltd., Borneo). pp 22p, Session II, Paper 1 of Fifth international conference on liquefied natural gas. Volume I. Chicago; Institute of Gas Technology (1977).

From 5. international conference on liquefied natural gas; Dusseldorf, F.R. Germany (29 Aug 1977).

See CONF-770879—P1.

Early 1968, Shell assumed the role of leader for the Brunei-Japan project. This paper refers particularly to the liquefaction plant. Construction of the plant started in March 1970. The first of the five liquefaction units came on stream in October 1972 and in 1976 the plant began to operate at design capacity. The purpose of this paper is to review some of the design concepts and the operating experience gained in the liquefaction plant. It highlights the factors which made it possible to fulfil and exceed the contractual delivery obligations in spite of the occurrence of a number of technical problems.

25837 First years of operation of the Skikda LNG plant with a discussion of mercury chemical corrosion of aluminum cryogenic exchangers. Khenat, B.; Hasni, T. (SONATRACH, Algiers). pp 17p, Session II, Paper 2 of Fifth international conference on liquefied natural gas. Volume I. Chicago; Institute of Gas Technology (1977). (In French)

From 5. international conference on liquefied natural gas; Dusseldorf, F.R. Germany (29 Aug 1977).

See CONF-770879—P1.

The Skikda Plant is entering its fifth year of operation after a start-up period. This start-up phase is presented through the different major technical operating troubles, contractual problems between the owner and the contractor, and the training and assignment of the owner's operating staff. A general idea is also given about the performances obtained up to this date by the plant in general and by some large equipments such as the axial refrigeration compressors, cryogenic exchangers, LNG storage tanks, etc. During the first year of production, the liquefaction plant underwent serious damages which immobilized the first unit for nearly 2 years. The cryogenic exchangers and the damages are described. Studies were carried out by Sonatrach and the results given. Recommendations are given regarding the mercury and liquefaction of natural gas.

25838 Operational flexibility of LNG plants using the propane precooled multicomponent refrigerant MCR process. Chatterjee, N.; Gaumer, L.S.; Geist, J.M. (Air Products and Chemicals, Inc., Allentown, PA). pp 20p, Session II, Paper 3 of Fifth international conference on liquefied natural gas. Volume I. Chicago; Institute of Gas Technology (1977).

From 5. international conference on liquefied natural gas; Dusseldorf, F.R. Germany (29 Aug 1977).

See CONF-770879—P1.

The Propane Precooled Multicomponent Refrigerant Cycle for natural gas liquefaction offers a unique type of flexibility which enables the MCR Cryogenic Heat Exchanger to operate over a very wide range of conditions while maintaining high overall plant efficiency and operating large compressors (above 25,000 kW) without recycle. The operating flexibility of the multicomponent refrigeration section is greater than that for conventional, single component, refrigeration systems. The primary variables that provide flexibility of operation are the mixed refrigerant composition; the suction pressure, discharge pressure, and speed of the mixed refrigerant compressor; and the speed of the propane compressor. Examples are presented showing how differences in feed composition, turndown requirements, off-design equipment performance, uncertainties in enthalpy and vapor-liquid equilibrium data, etc., can be accommodated within the existing system without sacrificing the overall plant efficiency.

25839 Electricity generation by utilization of LNG-cold. Pocrnja, A. (Linde AG, Munich); Streich, M.; Weber, D. pp 27p, Session II, Paper 11 of Fifth international conference on liquefied natural gas. Volume I. Chicago; Institute of Gas Technology (1977).

From 5. international conference on liquefied natural gas; Dusseldorf, F.R. Germany (29 Aug 1977).

See CONF-770879—P1.

After pumping on usual pipeline pressures, LNG has a recoverable exergy of about 0.1 kWh/Nm³ LNG. Due to the tremendous amount of landed LNG, the exergy potential of modern large terminals is on the order of 100 MW. In the past, the primary interest was directed to the direct utilization of the cold of LNG either for cooling purposes or for energy savings in different low temperature processes. In the first part of the paper some of these applications will be discussed. There are two principal handicaps in the direct utilization of LNG-cold, namely the coupling of two different process plants and the magnitude of the available cold, which have prevented an intensive utilization. These handicaps do not exist, or only on a lower scale, if the exergy of the cold is transformed into electrical energy. Several proposals have been made for this transformation. The paper deals with two new processes. The first one is a cold cycle using only heat from the surroundings. The second process is a closed gas-turbine loop, fed with high temperature heat and showing the peculiarity, that more than one kWh electrical energy is additionally produced per kWh cold-exergy.

25840 Nitrogen gas turbines for LNG regasification. Haselbacher, H. (BBC Brown Boveri and Co., Ltd., Baden, Switzerland). pp 15p, Session II, Paper 12 of Fifth international conference on liquefied natural gas. Volume I. Chicago; Institute of Gas Technology (1977).

From 5. international conference on liquefied natural gas; Dusseldorf, F.R. Germany (29 Aug 1977).

See CONF-770879—P1.

Among several methods of LNG regasification the process employing a closed-cycle gas turbine with the LNG as heat sink is both very economical and beneficial to the environment. This paper describes the design of a standard nitrogen gas turbine for a plant with an LNG regasification rate of 210 t/h. The electrical output of the turbine is 44 MW, and the corresponding thermal efficiency is above 44 percent. For larger regasification rates several identical units will be used. The basic design of the turbogroup is similar to that of BBC's open cycle gas turbines. A deviation from conventional gas turbine cycles is the low compressor inlet temperature (-129°C) requiring insulation of the casing and other stationary parts to prevent icing and to reduce thermal stresses. The generator is driven from the compressor end of the turbogroup. The thrust bearing and the slow turning device are located on the connecting shaft between turbo-group and generator. The standard gas turbine is supplied with hot nitrogen from a heater designed for burning heavy fuel oil. In this case the turbine inlet temperature is limited to 520°C. As alternatives, this paper discusses two additional designs: (1) A closed-cycle gas turbine with a turbine inlet temperature of 720°C. This is possible if the nitrogen heater is fired by natural gas. The thermal efficiency reaches 52 percent. (2) Another possible heat source is the exhaust gas of an open-cycle gas turbine. The thermal efficiency of such a combined plant is in the order of 48 percent. The standard nitrogen turbine can be adapted to these alternative designs with relatively minor changes.

25841 LNG offshore handling. Backhaus, H.W. pp 18p, Session IV, Paper 11 of Fifth international conference on liquefied natural gas. Volume II. Chicago; Institute of Gas Technology (1977).

From 5. international conference on liquefied natural gas; Dusseldorf, F.R. Germany (29 Aug 1977).

See CONF-770879—P2.

Different types of offshore LNG plants for the exploitation of small and distant offshore gas fields have been developed worldwide. The off-shore liquefaction concept has one critical point, which is the LNG transfer from the production platform to the exporting tanker. This is particularly true if the offshore liquefier is to be operated in adverse weather and sea conditions as they prevail in the North Sea. Subject of the paper is an LNG offshore handling system, specially designed for inclement weather and sea conditions. Components of the system (submarine LNG pipeline, submerged flexible LNG hose and mooring buoy, low temperature swivel- and rigid joints) are described together with the various problems of subsea positioning and installation. Particular attention has been given to the problems of the cryogenic liquid (boil-off, flash gases), the pipe insulation and the weight coating in order to control buoyancy. The comprehensive and costly research and development programme, which includes computer equipped basin tests, is sponsord by the Government of the Federal Republic of Germany.

HEALTH AND SAFETY

REFER ALSO TO CITATION(S) 25802

25842 Controlling the hazards from LNG spills on ground LNG fire fighting methods. Bellus, F.; Cochard, H.; Vincent, R.; Mauger, J. (Gaz de France, Paris). pp 30p, Session III, Paper 5 of Fifth international conference on liquefied natural gas. Volume II. Chicago; Institute of Gas Technology (1977). (In French)

From 5. international conference on liquefied natural gas; Dusseldorf, F.R. Germany (29 Aug 1977).

See CONF-770879—P2.

Gaz de France has developed a mathematical model to calculate vapour dispersion from accidental LNG spills on land. This model has been applied to make clear the influence of certain parameters in reducing the extension of the plumes. Based on the results of calculations, provided that basic safety features were included in the design and building of the LNG facilities, various types of impounding areas can be considered which are able to minimize the methane cloud travel in case of an accidental LNG spill. An example is given in the paper. A method to calculate the water spray rates for the protection of LNG tank walls from the energy radiated by an adjacent fire is described and a numerical example is given. Results are also given for tests carried out on high expansion foams which were found suitable for controlling LNG fires very rapidly. Finally the authors describe the details of design and construction of the new 80,000 m3 LNG tank at Fos. These embody the results of the studies mentioned above.

25843 Safety and reliability of floating LNG production facilities. Solberg, D.M.; Nylund, J.; Hansen, H.R. (Det Noske Veritas, Oslo). pp 17p, Session III, Paper 6 of Fifth international conference on liquefied natural gas. Volume II. Chicago; Institute of Gas Technology (1977).

From 5. international conference on liquefied natural gas; Dusseldorf, F.R. Germany (29 Aug 1977).

See CONF-770879—P2.

Det norske Veritas has been heavily engaged in safety related aspects for planned floating LNG production and storage facilities. This has resulted in guidelines for the construction and classification of such facilities. The objective of classification is to ensure an adequate standard of the facilities with respect to safety and reliability, and will provide assurance that during operation the safety against hazards for the facility, personnel and environment is acceptably high, and the reliability of the facility in the performance of its intended functions is acceptably high. This paper gives a survey of the guidelines which represents a concept covering design, manufacturing, installation, testing, and operating phases. The paper deals with the special conditions for floating plants.

25844 Risk management in marine transportation of LNG. Mathiesen, T.C.; Flatseth, H.H.; Solberg, D.M.; Tveit, O.J. (Det Norske Veritas, Oslo). pp 27p, Session IV, Paper 3 of Fifth international conference on liquefied natural gas. Volume II. Chicago; Institute of Gas Technology (1977).

From 5. international conference on liquefied natural gas; Dusseldorf, F.R. Germany (29 Aug 1977).

See CONF-770879—P2.

Marine transportation of LNG will continue to increase in the years to come, and will be characterized by both increasing number of ships as well as by increasing ship sizes. The paper presents a brief survey of present knowledge of the LNG hazard as occurring in connection with marine transportation of LNG. Furthermore, the different means related to design, construction and operation with the objective to eliminate or reduce the risks to an acceptable level are being presented. All these activities may be defined to constitute a risk management system. However, a more systematic program for risk management for each transportation scheme should be established and executed from design throughout construction and operation to ensure acceptable levels of safety for personnel, environment and property in a time with increasing emphasis on different safety aspects. Further, such a program will be needed, not only for ensuring and maintaining this important quality characteristic, but perhaps more important as a documentation to the public and authorities that all safety aspects are properly being taken care of. The paper presents a management approach to the safety problem as a whole, which is considered to meet the needs in this respect.

MARKETING AND ECONOMICS

REFER ALSO TO CITATION(S) 25722

25845 Fifth international conference on liquefied natural gas. Volume I. Chicago; Institute of Gas Technology (1977). 409p. (In English and French). (CONF-770879—P1). for Volumes I and II.

From 5. international conference on liquefied natural gas; Dusseldorf, F.R. Germany (29 Aug 1977).

Nineteen papers are presented under the two session headings: the role of LNG in the world energy supply, and LNG technology and its economic implications. Separate abstracts were prepared for all 19 papers. (DLC)

25846 World natural gas: 1975. Washington, DC; Bureau of Mines (1977). 8p.

In 1975, world marketed production of natural gas (NG) totaled 47,207 x 10^9 ft^3, only 0.1% higher than during 1974. Gross production of NG exceeded marketed production by 9,116 x 10^9 ft^3. NG movements in international trade increased from 5.7% in 1971 to 10.1% in 1975. LNG shipments in 1975 were equivalent to 786 x 10^9 ft^3. (3 tables) (DLC)

25847 Prospects of LNG export and its limitations. Mossadeghi, T. pp 11p, Session I, Paper 1 of Fifth international conference on liquefied natural gas. Volume I. Chicago; Institute of Gas Technology (1977).

From 5. international conference on liquefied natural gas; Dusseldorf, F.R. Germany (29 Aug 1977).

See CONF-770879—P1.

The uneven distribution of gas reserves among the countries of the world and the unconformity in regional demand and supply for this source of energy has given rise to the problem of bridging the distances between major gas producers and consumers. The geographical location imposes certain limitations on the export of natural gas by pipelines, and thus the prospect of future international gas trade largely depends on LNG. LNG export projects, however, are confronted with many problems, the major ones being the costs of liquefaction and transportation. Although the resultant delivered cost at destination is above the present price of natural gas in most areas, it is lower than the cost of other environmentally acceptable sources of energy. In the absence of a major breakthrough, the possibility of greatly reducing the cost of LNG is meager. Modest savings can, however, be made in many areas by optimizing plant and ship design. This paper discusses the above-mentioned issues in some detail and provides facts and figures with respect to the comparative cost of alternate sources of clean energy.

25848 Future market for LNG in the United States. Gambs, G.C. (Ford, Bacon and Davis, Inc., New York). pp 26p, Session I, Paper 2 of Fifth international conference on liquefied natural gas. Volume I. Chicago; Institute of Gas Technology (1977).

From 5. international conference on liquefied natural gas; Dusseldorf, F.R. Germany (29 Aug 1977).

See CONF-770879—P1.

Natural gas now accounts for 28 percent of the total U. S. energy consumption and is expected to decline to 20 percent by 1985. Current production of natural gas in the United States is less than 20 trillion cubic feet per year. Forecasts for 1985 production range from 13 to 17 trillion cubic feet, leaving a shortage of 3 to 7 trillion cubic feet (0.085 x 10^{12} to 0.199 x 10^{12} cubic metres) per year. Imported LNG into the United States is not expected to exceed 1.5 trillion cubic feet per year by 1985 and may be as low as 0.5 trillion cubic feet. Thus one can conclude that the USA can absorb all the imported LNG which can be contracted for and delivered during the next 10 to 25 years. Prices of LNG will be as high or higher than imported oil and by 1985 will be between $4 to $5 per Mcf or $4 to $5 per million Btu ($3.79 per GJ to $4.74 per GJ) compared with $28 per barrel for oil ($176.12 per cubic metre) which is equal to $4.67 per million Btu ($4.42 per GJ). Because the imports of LNG into the USA will be concentrated in the Middle and South Atlantic states and Pacific coast states, LNG will constitute a very large percentage of the total gas supply in those regions. In the case of the Atlantic coast, LNG will account for 39 percent of the total region's gas supply, while on the West Coast, LNG will account for only 11 percent of that region's gas supply. By 1985, LNG will account for only 8 to 10 percent of total USA natural gas supply and only 1.5 to 2.0 percent of the total U.S. energy consumption.

25849 Situation of LNG in Europe. Bonfiglioli, G.; Centeno, R.; Pilloy, M.; Soille, P. pp 16p, Session I, Paper 3 of Fifth international conference on liquefied natural gas. Volume I. Chicago; Institute of Gas Technology (1977). (In French)

From 5. international conference on liquefied natural gas; Dusseldorf, F.R. Germany (29 Aug 1977).

See CONF-770879—P1.

In Europe in 1964, the first commercial deliveries of LNG started with the LNG systems ARZEW (Algeria), CANVEY ISLAND (United Kingdom), and ARZEW-LE HAVRE (France). Since then other LNG systems have been taken into service namely Libya-Spain, Libya-Italy, Algeria-France so that at the present time the import of LNG in Europe reaches 8.4 billion Nm3 per year. Moreover, by taking advantage of existing plants, LNG has been carried from Algeria to Spain. New LNG systems, as a result of recently concluded contracts between Algeria, Belgium, France and Italy, will increase the quantity of imported LNG up to 31 billion m3 per year in 1982. This report gives an account of the situation in Belgium, Italy, France and Spain, concerning the receiving of LNG. It also shows how LNG is used in these various countries and gives the main data of the systems under realization.

25850 Japan's energy policy and role of LNG. Hirakawa, S. (Tokyo Univ.); Kusano, S. pp 9p, Session I, Paper 5 of Fifth international conference on liquefied natural gas. Volume I. Chicago; Institute of Gas Technology (1977).

From 5. international conference on liquefied natural gas; Dusseldorf, F.R. Germany (29 Aug 1977).

See CONF-770879—P1.

Catching the points of Japan's energy issues, LNG would be expected to play a very important role in its domestic energy supply and demand in order to diminish dependency on oil imports, promote energy saving, and preserve the environment. New LNG projects will have to be introduced into the Japanese market to meet the large amount of potential demand. But, there are some obstacles to be hurdled. They are (1) identification and efficient organization of adequate markets; (2) financing for development of gas fields and construction of liquefaction plants, LNG tankers, LNG storage tanks and other receiving facilities, and transmission/distribution pipelines and so on. It is expected that these problems will be solved thanks to intensive study, which is under way, with the aim of making a new achievable program of LNG supply to meet the nation's energy goal.

25851 World LNG trade: present status and long term prospects. Peebles, M.W.H. (Shell International Gas Ltd., London). pp 24p, Session I, Paper 7 of Fifth international conference on liquefied natural gas. Volume I. Chicago; Institute of Gas Technology (1977).

From 5. international conference on liquefied natural gas; Dusseldorf, F.R. Germany (29 Aug 1977).

See CONF-770879—P1.

This paper reviews the present status and long term prospects for the international sea-borne LNG trade. It concentrates on the United States, Western Europe and Japan, and discusses possible supply sources to meet the prospective demand in these markets. Apart from supply and demand, two other subjects have been selected for discussion. The first is prices and related pricing considerations, and the second, the availability of and requirement for LNG ships in the period up to 1990.

25852 LNG peak-shaving plant at Maasvlakte. Bijl, P.; Vet, P.N. (N. V. Nederlandse Gasunie, Groningen). pp 11p, Session II, Paper 4 of Fifth international conference on liquefied natural gas. Volume I. Chicago; Institute of Gas Technology (1977).

From 5. international conference on liquefied natural gas; Dusseldorf, F.R. Germany (29 Aug 1977).

See CONF-770879—P1.

In order to comply with the natural gas consumption during cold periods in the most densely populated area in The Netherlands a peak-shaving installation has been built on the Maasvlakte near Rotterdam. The installation is unique in its kind, insofar that two liquid products are produced, LNG and liquid nitrogen (LN2), which are stored separately. To obtain during peak-shaving a gas which must be compatible with gas from the Groningen field special care must be taken with the blending of LNG and LN2 during regasification. In the preliminary phase of the liquefaction special attention is given to the presence of mercury in the feedgas. Almost 85 percent of the total energy required for the liquefaction is obtained by expanding 150,000 Nm^3 natural gas in an expansion turbine. The gas is then used as underboiler fuel in a near-by electric power station. The net production of the liquefaction plant is 13,000 Nm^3/h LNG and 2,800 Nm^3/h LN2. The liquid products are stored in two 57,000 m^3 LNG tanks and one 19,000 m^3 LN2 tank of the double metal wall type. The LNG tanks are surrounded by 32 m. high, 0.4 m. thick prestressed concrete walls. Separate regasification of LNG and LN2 with a combined maximum capacity of one million Nm^3 per hour is achieved by 8 LNG and 2 LN2 vaporizers of the submerged combustion type.

25853 Financing aspects of LNG trade. Batkin, A.R.; Goodspeed, R.H. (Lehman Brothers Inc., New York). pp 15p, Session III, Paper 7 of Fifth international conference on liquefied natural gas. Volume II. Chicago; Institute of Gas Technology (1977).

From 5. international conference on liquefied natural gas; Dusseldorf, F.R. Germany (29 Aug 1977).

See CONF-770879—P2.

The requirements for financing the various aspects of LNG trade are extremely complex due to the size of the projects and the interaction of the various countries in an LNG program. This paper explores the optimal criteria for an LNG financing program and various means of achieving the objectives. Techniques discussed include take-or-pay contracts, leasing, commercial paper and government guarantee programs. The structure of these approaches is reviewed along with the technical problems associated with them. The applicability of the various forms of financing to the different elements in the LNG cycle is then analyzed. Finally, the contractual relationships between the parties is discussed along with the effects of such contracts on financing.

25854 Contribution of the Export—Import Bank of Japan to Japanese LNG projects. Hirakawa, S. (Tokyo Univ.); Ito, R. pp 13p, Session III, Paper 8 of Fifth international conference on liquefied natural gas. Volume II. Chicago; Institute of Gas Technology (1977).

From 5. international conference on liquefied natural gas; Dusseldorf, F.R. Germany (29 Aug 1977).

See CONF-770879—P2.

The Export-Import Bank of Japan renders a positive financial help to Japanese LNG projects. The authors present the object of the foundation, business details or the like of the Bank and, in light of the importance of role of LNG playing in the field of Japan's primary energies, introduce the LNG projects relating to the Bank. The authors indicate technological problems arising in connection with the financial assistance and refer to the confirmation of gas reserves and the prediction of gas production based on the petroleum reservoir engineering, and further to technological matters for examination including liquefying equipment, storing and shipping facilities, etc. The final part of the paper deals with the said Bank's view and future policy set forth in terms of the LNG projects.

25855 Project financing of LNG trade. Lewand, S.J.; Meyer, G.R. (Chase Manhattan Bank, New York). pp 12p, Session III, Paper 9 of Fifth international conference on liquefied natural gas. Volume II. Chicago; Institute of Gas Technology (1977).

From 5. international conference on liquefied natural gas; Dusseldorf, F.R. Germany (29 Aug 1977).

See CONF-770879—P2.

It is important to view LNG trade at this stage of its development in a project mode recognizing that risk evaluation by lenders and investors will be made in the context of the interdependency of the components of the LNG system and the need for the supply/demand circle to be closed before committing to the investments. We are examining projects, for purposes of this paper, of extraordinary dimensions, and their call not only upon the diverse financial markets of the world but also upon the economic resources of producer and consumer countries as well. Of considerable significance will be the relationship between the financial needs of worthy projects, and the time interval or "window" when the demands on the capital markets will occur. It is apparent that an untimely confluence of demands could result in the crowding out of less attractive projects, despite their intrinsic merits. We propose to describe the "project finance" concept for financing large scale LNG ventures, attempt to define risks, and examine the processes by which capital may be attracted to support such projects.

25856 World LNG trade and the competitiveness of present and projected prices. Seay, J.G.; Anderson, P.J.; Daniels, E.J. (Inst. of Gas Tech., Chicago). pp 12p, Session III, Paper 12 of Fifth international conference on liquefied natural gas. Volume II. Chicago; Institute of Gas Technology (1977).

From 5. international conference on liquefied natural gas; Dusseldorf, F.R. Germany (29 Aug 1977).

See CONF-770879—P2.

Projections of both U. S. and international LNG trade are compared and analyzed. A world LNG trade between 6.8 and 12.3 billion CF/day is possible by 1985. U. S. LNG trade could be between 1.1 and 6.5 billion CF/day depending on U. S. Federal and State government policies and actions. President Carter's National Energy Plan, if carried out, could severely restrict LNG imports to the U. S.

25857 Fifth international conference on liquefied natural gas. Volume II. Chicago; Institute of Gas Technology (1977). 414p. (In English and French). (CONF-770879—P2). for Volumes I and II.

From 5. international conference on liquefied natural gas; Dusseldorf, F.R. Germany (29 Aug 1977).

Twenty-two papers are included under the session headings: financing, legal and policy aspects of LNG trade; and transportation of LNG. Separate abstracts were prepared for all 22 papers. (DLC)

WASTE MANAGEMENT

REFER ALSO TO CITATION(S) 25797

ENVIRONMENTAL EFFECTS

REFER ALSO TO CITATION(S) 25802

25858 (DOE/EV—0002) **Approach to liquefied natural gas (LNG) safety and environmental control research.** (Department of Energy, Washington, D.C. (USA). Div. of Environmental Control Technology). Feb 1978. 464p. Dep. NTIS, PC A20/MF A01.

LNG presents a partial solution to the energy shortage of the nation. Through liquefaction, it becomes possible to consider importation of large quantities of gas from overseas suppliers. Increased storage of LNG at critical regional locations within the nation can facilitate distribution of gas during seasonal periods of high demand. Regulatory bodies at all levels of government appear reluctant to grant licensing approval for LNG operations because of safety and environmental concerns resulting from limited data about the consequences of a major LNG accident. Increased understanding of LNG hazards will provide information for development of sites and control systems about which public judgments regarding acceptability can be more quickly and equitably made. LNG safety and control information is presented for use by industry, regulatory bodies, and the general public. Two objectives have been established: verified predictive capabilities and verified control methods. To achieve these objectives, activities in six technical elements have been identified: vapor generation and dispersion; fire and radiation hazards; flame propagation; release prevention and control; instrumentation and technique development; scale effects experiments. Research will be subjected to continuing evaluation which will provide the basis for any program redirection. Assuming no technical difficulties, the program can be completed in 5 years. To effect this program in its entirety will require an estimated $50 million.

ARTIFICIAL STIMULATION, PLOWSHARE, ETC.

REFER ALSO TO CITATION(S) 25745, 26857

25859 (LA—7094-PR) **Evaluation of methods for stimulation and characterzation of eastern gas shales. Progress report, April—June 1977.** Carter, W.J.; Vanderborgh, N.E. (comps.). (Los Alamos Scientific Lab., N.Mex. (USA)). Jan 1978. Contract W-7405-ENG-36. 26p. Dep. NTIS, PC A03/MF A01.

Work was initiated at the Los Alamos Scientific Laboratory during the third quarter of FY 77 to develop new technology for enhancing the rate of recovery of methane from gas shales located in the eastern United States. Explosively driven jet penetrators are being evaluated as a means of increasing drainage rates from a particular formation. This technology would permit the creation of horizontal passages from a vertical bore to facilitate gas drainage. Preliminary studies of the response of Eastern shales to dynamic stress are reported. These results will suggest the optimum design criteria for jet-forming devices. Work is also reported on computer modeling of gas drainage that should result with wells opened with jet devices. These results show a marked increase in flow during the early stages of a jet-stimulated well. Characterization studies using laser-induced pyrolysis for the rapid determination of oil and gas content have begun. Much of this activity has concentrated on assembling instrumentation for these measurements. Initial characterization of Devonian core samples using electron microprobe instrumentation is reported. These data suggest necessary sampling conditions for subsequent analysis procedures.

25860 Mesaverde hydraulic fracture stimulation, northern Piceance basin: progress report. Chancellor, R. (Rio Blanco Natural Gas Co., Denver). pp 285-291 of Exploration frontiers of the central and southern Rockies. Veal, H.K. (ed.). Denver; Rocky Mountain Association of Geologists (1977).

From Symposium program RMAG fall field conference; Snowmass, CO, USA (29 Sep 1977).

See CONF-770972—.

Information gained from massive stimulation projects in northern Piceance basin was used to design a massive hydraulic fracture for a 130 foot thick Mesaverde Group interval in a nearby well. Pre-frac log interpretations indicated individual sandstone units in the zone to be gas productive with variable reservoir characteristics. It flowed 55 MCFPD after a pre-frac breakdown to 16 perforations. Seven thousand barrels of jelled KCl water and 775,000 lb of sand were injected at the rate of 37 barrels per minute. With 70% fluid recovery after 12 post-frac days, the flow rate was 800 MCFPD. After one month, it dropped to 200 MCFPD and stabilized at 130 MCFPD plus an average of 3 barrels of high gravity oil and 3 barrels of water after four months on $\frac{1}{4}$ in choke at 60 pounds tubing pressure. These results are similar to two previous KCl based fracs performed in the well. The KCl approach to drilling and completing Mesaverde wells in this area appears to offer economically successful stimulation ratios.

25861 Application of massive hydraulic fracturing to the tight Muddy "J" Formation, Wattenberg field, Colorado. Fast, C.R.; Holman, G.B.; Covlin, R.J. (Amoco Production Co., Denver). pp 293-300 of Exploration frontiers of the central and southern Rockies. Veal, H.K. (ed.). Denver; Rocky Mountain Association of Geologists (1977).

From Symposium program RMAG fall field conference; Snowmass, CO, USA (29 Sep 1977).

See CONF-770972—.

Laboratory and field research in Colorado's Wattenberg field showed that commercial gas production was feasible from the very tight Muddy "J" Formation using massive hydraulic fracturing. Results indicate that the largest treatments are economically justified in the better areas of the field.

POLICY, LEGISLATION, AND REGULATION

REFER ALSO TO CITATION(S) 25806

25862 (EMD—78-10) **Emergency natural gas purchases: actions needed to correct program abuses and consumer inequities.** (General Accounting Office, Washington, D.C. (USA)). 6 Jan 1978. 47p. Accounting Office, Washington, DC $1.00.

Report to the Congress by the Comptroller General of the United States.

Large quantities of natural gas were allowed to be purchased on an emergency basis by interstate pipeline companies under the Emergency Natural Gas Act of 1977 and the emergency purchase provisions of the Federal Power Commission. Yet no restrictions were applied in terms of what constituted an emergency or what priorities should govern the use of emergency natural gas. Many interstate pipeline companies used these emergency purchases to increase or maintain sales to low-priority customers that could use alternate fuels. Such actions are counter-productive to national conservation policies. Also they are inequitable because high-priority customers not affected by curtailment were forced to bear part of the higher cost of emergency purchases, thereby subsidizing low-priority users. Recommendations are made for establishment of a firm policy that emergency provisions be used only to supply high-priority uses. It is also recommended that the Congress give the President permanent authority to declare a natural gas emergency and to require mandatory allocation of natural gas between pipeline companies during the emergency.

25863 **Legal problems of long term LNG contracts.** Soesan, J.M. pp 12p, Session III, Paper 1 of Fifth international conference on liquefied natural gas. Volume II. Chicago; Institute of Gas Technology (1977).

From 5. international conference on liquefied natural gas; Dusseldorf, F.R. Germany (29 Aug 1977).

See CONF-770879—P2.

The considerable sums required to launch an LNG project make it essential that the various contracts necessary for its implementation will be effective for long periods, usually 15 to 20 years. Recently, doubts have been expressed as to the 'sanctity' of such contracts when the surrounding circumstances change and the paper will examine whether, in fact, such contracts can be relied upon. The theory of "the unforeseen" in certain legal systems will be examined in this connection. Moreover, those involved in the drafting and negotiation of such contracts must have the foresight to deal with possible changes in the circumstances surrounding the project during its lifetime and must consider the effects upon the contract, not only of the actions of the parties thereto, but of the actions of governments and their agencies and also the effect of general economic and monetary changes. The paper will examine how one may deal with the more important of these changes.

TRANSPORT, PIPELINES, AND HANDLING

REFER ALSO TO CITATION(S) 25807, 25808, 25841, 25844, 25845, 25852, 25857, 25863, 25888, 26704

25864 **Ekofisk-Emden gas pipeline.** Anon. *North. Offshore;* **6**: No. 10, 36, 39(Oct 1977).

This article highlights the 275-mile 36-in.-diameter submarine pipeline which has recently begun to transport natural gas from the Ekofisk field in the Norwegian sector of the North Sea to Emden, a seaport in West Germany. Also briefly described is the Emden gas treatment plant which is designed to process up to 60 million cu meters/day of Ekofisk natural gas. This processing involves the removal of small amounts of sulfur compounds by means of molecular-sieve treaters. The line permits the exploitation of associated gas which was previously re-injected into the seabed.

25865 **Profile of the Southern Feeder.** De Winton, C. *Gas World Gas J.;* **182**: No. 4707, 533-535, 537-538, 840-841(Oct 1977).

This article highlights the Southern Feeder pipeline in the U.K., which is nearing completion. This line, linking Devon with Cambridgeshire will play an important strategic role in the distribution of natural gas throughout Southern England in the forthcoming Frigg area of gas supply. Some problems encountered in the construction of the feeder pipeline are discussed, including the problems of varied terrain and of blue clay.

25866 **Studies on defect occurrence of LPG tank insulation executed in winter.** Yamaguchi, T.; Oku, K.; Takano, O.; Masuda, T. *Kawasaki Giho;* No. 63, 82-87(Mar 1977). (In Japanese).

The cargo tank insulation in an LPG carrier is made of rigid polyurethane foam molded in place by the frothing process. Experience shows that the rigid foam molded in winter is liable to have more defects, such as separation from joist, crack, void, etc., than in summer. This is mainly caused by a big difference between the ambient temperature and the temperature of the insulation material itself due to polymerization reaction heat. It is possible to reduce these defects by controlling the raw material liquid temperature, mixing ratio, quantity of catalyst and mixing speed/amount of blowing agent. Under optimal conditions obtained by controlling the abovementioned factors, the rate of defect is reduced to about one-fourth. This paper describes the result of experiment and fundamental data for preparing rigid foam molded in winter.

25867 **Movements and stress characteristics of LNG piping.** Tanaka, S.; Yamamoto, M.; Iimoto, K.; Satani, M.; Tanabe, T. *Kawasaki Giho;* No. 63, 94-99(Mar 1977). (In Japanese).

Since LNG piping is cooled to -163°C, thermal stresses occur due to the contraction of piping between anchor points. We designed the piping system so that the stresses of the LNG piping were decreased by expansion bends. We had already calculated the stresses of the LNG piping and found that they were smaller than the allowable stress. Before installation, we measured the movement and stresses for a part of the LNG piping cooled by the liquefied nitrogen. As a result, we confirmed that our piping design was satisfactory.

25868 **Transfer system of completed spherical tank for LNG carrier.** Murata, Y.; Yonekura, I.; Minakata, S.; Shikata, H.; Sekito, N.; Kanoh, J.; Ohtsuka, Y. *Kawasaki Giho;* No. 63, 234-241(Mar 1977). (In Japanese).

Japan's first spherical tanks for LNG carriers have been fabricated under very high quality control at our Harima Works, which is the most up-to-date factory specializing in LNG tank production. Up to now, four tanks have been already completed, and it can be safely said that KHI has established a continuous production system. In this paper, as an important part of this production, the transfer system of completed tanks is introduced. This system will provide a valuable guide for the development of very large-size structure construction techniques.

25869 **Review of current LNG ship technology and an attempt to rationalize.** Ffooks, R.C. pp 18p, Session I, Paper 4 of Fifth international conference on liquefied natural gas. Volume I. Chicago; Institute of Gas Technology (1977).

From 5. international conference on liquefied natural gas; Dusseldorf, F.R. Germany (29 Aug 1977).

See CONF-770879—P1.

There are now almost 25 different designs for LNG tankers available; some have commercial operating experience behind them, some have none. Each is briefly discussed. The paper then attempts an objective comparison of the systems, with a view to pointing the way towards a greater degree of rationalization in this highly technological, and at the same time politically influenced, field.

25870 **LNG plants on floating structures: intermediate report on an extensive test program.** Berger, E. (Linde AG, Munich). pp 24p, Session II, Paper 5 of Fifth international conference on liquefied natural gas. Volume I. Chicago; Institute of Gas Technology (1977).

From 5. international conference on liquefied natural gas; Dusseldorf, F.R. Germany (29 Aug 1977).

See CONF-770879—P1.

Offshore natural gas production by liquefaction on floating structures, followed by unloading and transportation in LNG carriers, promises to be advantageous over conventional methods for conveying natural gas to consumers in pipelines. This is especially so for marginal offshore gas fields, or offshore oil fields with associated gas or even for onshore fields where there is a lack of infrastructure. The proposed systems fill a market gap where fixed platform/subsea pipeline methods or onshore LNG plants have reached the limit of economic viability. The processing of natural gas on floating platforms presents many challenging problems associated with the motions of the platform and with the need for maximum gas recovery, minimum space and weight requirements for the processing plant. Two groups of companies, ARGE 76 and CONSORTIUM 76 are engaged in a two-year development program, which will culminate in the final design for two offshore natural gas liquefaction systems by mid 1978. The participating companies are BILFINGER + BERGER, BLOHM + VOSS, DYCKERHOFF and WIDMANN, KABELMETAL, LINDE, PREUSSAG and TECHNIGAZ (a subsidiary of GAZOCEAN). Solutions to the above problems developed from theoretical and experimental investigations are described.

25871 **Algerian perspective on maritime transport of LNG.** Hasmim, A. (National Algerian Maritime Shipping Co., Algiers). pp 6p, Session IV, Paper 1 of Fifth international conference on liquefied natural gas. Volume II. Chicago; Institute of Gas Technology (1977).

From 5. international conference on liquefied natural gas; Dusseldorf, F.R. Germany (29 Aug 1977).

See CONF-770879—P2.

The reasons for Algerian authorities' decision to participate in transporting 50 percent of its gas are given. Financing and profit-

earning capacity of methane carriers are discussed. The time-charter contracts were decided on in preference to transport contracts. (DLC)

25872 Arctic islands LNG. Hindle, W. (TransCanada PipeLines, Toronto). pp 22p, Session IV, Paper 2 of Fifth international conference on liquefied natural gas. Volume II. Chicago; Institute of Gas Technology (1977).

From 5. international conference on liquefied natural gas; Dusseldorf, F.R. Germany (29 Aug 1977).

See CONF-770879—P2.

This paper outlines an investigation into the use of LNG tankers with icebreaking capabilities in Canadian Arctic waters to move isolated reserves of natural gas that are of insufficient volume to support construction of a pipeline. It includes a summary of special considerations involved in the construction of a gathering system, LNG plant, loading facility, the design of LNG carriers, as well as unloading and gasification facilities. Based upon the results of icebreaking tests in the Gulf of Bothnia, existing icebreakers supplemented by ice thickness surveys of Arctic regions adjacent to North America, it appears feasible to design and technically possible to construct Class 10 LNG carriers of a size capable of navigating Canadian Arctic shipping channels without icebreaker assistance. It appears that the use of a minimum of three Arctic Class 10 ships would enable delivery of volumes of natural gas averaging 11.3 million cubic meters (400 MMcf) per day over a period of a year to Canadian markets.

25873 LNG transportation by road tank trailers. Montet, A.; Przydrozny, M.; Inquimbert, R. (Gaz de France, Paris). pp 17p, Session IV, Paper 4 of Fifth international conference on liquefied natural gas. Volume II. Chicago; Institute of Gas Technology (1977). (In French)

From 5. international conference on liquefied natural gas; Dusseldorf, F.R. Germany (29 Aug 1977).

See CONF-770879—P2.

Gaz de France has proceeded for several years to road-transportation of LNG between the import receiving terminals of Le Havre or Fos, and the test center of Nantes, or other satellite plants. The first transportations were made with road tank trailers on hire. After many tests carried out at the Nantes test center, Gaz de France has ordered trailers in accordance with its own specifications. The authors develop the processes which have been adopted for the equipment of the trailers, for their loading and their unloading, and to secure the LNG transportation. The authors finally study the factors which take place in the reliability of road transport.

25874 Operational experience with LNG ships. Findlater, A.E.; Prew, L.R. pp 16p, Session IV, Paper 5 of Fifth international conference on liquefied natural gas. Volume II. Chicago; Institute of Gas Technology (1977).

From 5. international conference on liquefied natural gas; Dusseldorf, F.R. Germany (29 Aug 1977).

See CONF-770879—P2.

The paper discusses some of the experience gained during the initial years operation of the shipping phase of the Shell Brunei/Japan L.N.G. scheme. Cargo boil off, being one of the distinguishing features of these ships, is discussed in terms of causes and effects together with the steps taken to maximize utilization on board. The main cargo operations of loading, discharging, warming up, inerting and aeration are described principally as background to the initial choice of equipment and the performance of systems in practice. The safety aspects of L.N.G. transportation is discussed in terms of port authority requirements, terminal facility design and ship operational features. The paper also describes the operational planning required for the successful commissioning and operation of a fleet of gas carriers and the wide range of disciplines and expertise involved.

25875 Experiences in the commissioning of liquid natural gas carriers. Eke, P.W.A. (Canvey Methane Terminal, Canvey Island, Eng.); Gibson, G.H. pp 1-13, Session IV, Paper 6 of Fifth international conference on liquefied natural gas. Volume II. Chicago; Institute of Gas Technology (1977).

From 5. international conference on liquefied natural gas; Dusseldorf, F.R. Germany (29 Aug 1977).

See CONF-770879—P2.

British Gas has recently undertaken the role of commissioning new LNG carriers at their Methane Reception Terminal at Canvey Island, taking advantage of the deep water berthing facilities. These facilities are capable of receiving the largest LNG carriers built or under construction to date, and LNG, LPG and high pressure natural gas are available in bulk. Over the past 18 years extensive experience has been accumulated at Canvey in the operational and technological aspects of handling LNG. This experience includes cooldown, operation, warm up and inspection of a full range of cryogenic plant. A brief summary of this experience and the cryogenic and marine facilities at Canvey is given, together with examples of operational alternatives made possible because of equipment and pipework flexibility. The procedure followed including the precommissioning planning stages to the actual ship commissioning is given in detail emphasizing the importance of safety. Actual problems experienced and the solutions devised are discussed and notes given on the ship design differences and their effect on commissioning. Photographs, diagrams and relevant lists of ships and terminals are included.

25876 Twelve years operating experience with Methane Princess and Methane Progress. Vrancken, P.L.L. (Conch Methane Services Ltd., London); McHugh, J. pp 14-22, Session IV, Paper 6 of Fifth international conference on liquefied natural gas. Volume II. Chicago; Institute of Gas Technology (1977).

From 5. international conference on liquefied natural gas; Dusseldorf, F.R. Germany (29 Aug 1977).

See CONF-770879—P2.

The service record of these two ships, the first commercial LNG carriers in the world, is compared with the original targets set for them. The causes of any unplanned delays or outages are analyzed and an attempt made to predict their future performance and useful life.

25877 330000 m3 Verolme LNG carrier. Verolme, C.; Winkler, A.K. (Naval Project Development Co., Rotterdam). pp 10p, Session IV, Paper 7 of Fifth international conference on liquefied natural gas. Volume II. Chicago; Institute of Gas Technology (1977).

From 5. international conference on liquefied natural gas; Dusseldorf, F.R. Germany (29 Aug 1977).

See CONF-770879—P2.

This paper gives a description of the 330,000 m3 LNG carrier, the Very Large Gas Carrier (VLGC), developed for long distance transport of liquefied natural gas. The cryogenic containment system is a multi-container system especially suitable for the carriers of this size and providing a high degree of safety. At the design of the carrier, wherever possible, use is made of what already exists and is proven: the hull is a conventional containership design adapted to the need of the cryogenic containment system. The containment system consists of a number of vertical aluminium cylinders which are fabricated outside the ship. Special attention has been given to the safety aspect. The subjects considered in the paper are: the vessel itself (the hull), the cryogenic containment system including insulation, boil-off, loading and unloading of LNG, instrumentation, gauging, leak detection. This development therefore is believed to have created the next generation of LNG carriers.

25878 Prototype tank test of semi-membrane LNG carrier. Watanabe, E. (Sasebo Heavy Industries Co., Ltd., Japan); Furuta, K. pp 19p, Session IV, Paper 8 of Fifth international conference on liquefied natural gas. Volume II. Chicago; Institute of Gas Technology (1977).

From 5. international conference on liquefied natural gas; Dusseldorf, F.R. Germany (29 Aug 1977).

See CONF-770879—P2.

Sasebo Heavy Industries Co., Ltd. has conducted a technical development from 1973 to 1976 in order to bring into being the conception of LNG carrier of the semi-membrane type as previously reported by Bridgestone Liquefied Gas Co., Ltd. at the third International Conference on LNG in 1972. In this development, emphasis was placed on the study of stress distribution of the tank through computerized numerical analysis, method for the tank assembly and the type of secondary barrier. In the investigation of these problems, a prototype tank of 10 m long, 10 m wide and 8 m high was made and various tests including tank assembly, leak test and stress distribution, etc. have been carried out. As a result of the study, safety and reliability of the tank and economy of the semi-membrane tank system have been clarified. Also, on the safety and reliability of the tank, design approvals have been obtained from the Japanese Ministry of Transportation and U.S. Coast Guard.

25879 Spherical LNG tanks on continuous cylindrical skirts: a shipbuilder and licenser's experience. Toennessen, A. (Mos Rosenberg Verft AS, Norway). pp 32p, Session IV, Paper 9 of Fifth international conference on liquefied natural gas. Volume II. Chicago; Institute of Gas Technology (1977).

From 5. international conference on liquefied natural gas; Dusseldorf, F.R. Germany (29 Aug 1977).

See CONF-770879—P2.

After appearing in 1970, the skirtsupported spherical tank concept has gone through the complete cyclus of design, construction and commissioning. Operating experience has also been gained. The design has been licensed to several shipyards, of which three have ships in order. Safety and economy have been the principal design targets. Flexibility in adapting to shipyard and marked conditions has been proven through the use of different tank materials, insulation systems and fabrication procedures. The design is subject to continuous development. Current research offers interesting prospects of cost-cutting improvements, maintaining the safety.

25880 New Invar membrane containment system for construction of LNG carriers. Gilles, A.; Waisman, J.L. pp 26p, Session IV, Paper

10 of Fifth international conference on liquefied natural gas. Volume II. Chicago; Institute of Gas Technology (1977).

From 5. international conference on liquefied natural gas; Dusseldorf, F.R. Germany (29 Aug 1977).

See CONF-770879—P2.

The evolution of the GT/MDC liquefied gas containment system by Gaz-Transport and McDonnell Douglas is reviewed and the GT/MDC technique is described. The development of the McDonnell Douglas three-dimensionally reinforced insulation—called 3D—is described from its application in the United States space program, to its proposed use as an LNG carrier containment system in direct contact with the cargo, and to its present application as an insulation system and secondary barrier in conjunction with the Gaz-Transport Invar membrane primary barrier. The paper discusses how the GT/MDC technique meets the requirements of a containment system having a two-layered 3D insulation as an alternative to the Invar secondary barrier and perlite filled plywood boxes of the GT standard technique. Since the McDonnell Douglas insulation was combined with an existing and proven membrane system, tests were accomplished to demonstrate the compatibility to the 3D insulation with the existing Invar membrane. These tests are described. The paper concludes by describing the assembly process of the GT/MDC technique. The GT standard and GT/MDC techniques are then compared with respect to points in common, costs, and insulating efficiencies. 21 figs.

PROPERTIES

25881 Densities of LNG for custody transfer. Haynes, W.M.; Hiza, M.J.; McCarty, R.D. (National Bureau of Standards, Boulder, CO). pp 36p, Session III, Paper 11 of Fifth international conference on liquefied natural gas. Volume II. Chicago; Institute of Gas Technology (1977).

From 5. international conference on liquefied natural gas; Dusseldorf, F.R. Germany (29 Aug 1977).

See CONF-770879—P2.

A project has been carried out to provide experimental density data for liquefied natural gas components and their mixtures with a total uncertainty of less than 0.1 percent. The apparatus, data, experimental procedures, etc. are described. The assessment of the accuracy of the data has been propagated into estimates of financial inequities (bias) in the custody transfer of LNG. Several mathematical models for the calculation of LNG densities for custody transfer have been optimized, tested and compared. An assessment of the accuracy of the resulting models is given. The models optimized and tested include an extended corresponding states method, a hard sphere model, a cell model and an empirical model due to Klosek and McKinley. The extent to which the objective of predicting LNG densities within 0.1 percent of the true value from an input of pressure, temperature and composition has been achieved is discussed.

COMBUSTION

REFER ALSO TO CITATION(S) 25620, 26782

STORAGE

REFER ALSO TO CITATION(S) 25823, 25845

25882 (PB—269450) Bush dome model: computing movement of injected crude helium. Software. Moffitt, R.L.; Tongish, C.A.; Holmes, R.A. Jr. (Bureau of Mines, Washington, D.C. (USA)). Jun 1977. vp. (BM-CT—4-11). of Mines, Washington, DC.

A two-dimensional mathematical model has been developed by the Bureau of Mines, to simulate storage and withdrawal operations in a free gas reservoir. The program executes the mathematics of the partial differential equation for Darcy flow of three distinct gases, and can be used to simulate and predict pressure, withdrawal and injection information in gas reservoirs. The computing package consists of a main program and four support programs for preparing input data. Basic input data required are porosity, permeability and thickness arrays that describe these reservoir characteristics on an areal basis. In addition to these data, the program requires gas compressibility and viscosity information for the gases flowing in the reservoir. A document has been prepared to accompany the tape file entitled 'Bush Dome Model-Computing Movement of Injected Crude Helium, General Instruction Manual for Computer Program KWDX-577-MP for Computing Gas Movement in a Gas Storage Reservoir'...Software Description: The program is written in the Fortran programming language for implementation on an IBM 360/65 computer using the OS operating system. 512K bytes of core storage are required to oprate the mode.

25883 Refrigerated LPG storage and transfer facility for thermal power generation. *Kawasaki Giho;* **64**: No. 8, 103-105(Aug 1977). (In Japanese).

The KHI Steel Structure Manufacturing Division has recently built an LPG storage and transfer facility for the Anegasaki plant of the Tokyo Electric Power Co. The facility consists of LPG refrigeration tank, LPG transfer pumps, piping and instruments. The LPG storage tank is a perlite-insulated double walled tank, with a capacity of 40,000 kiloliters. The pumps are submerged motor pot-mounted LPG pumps and two of them continuously feed liquid LPG to the vaporizer at the rate of 110t/h.

25884 Brittle fracture initiation characteristics of thin mild steel plate for the gas barrier of LNG underground membrane tank. Ueda, K.; Kakehi, K.; Kanazawa, H.; Hidaka, H.; Kuramochi, Y. *Kawasaki Giho;* No. 63, 222-227(Mar 1977). (In Japanese).

One of the special features of the KHI LNG underground membrane tank is a thin steel plate, called "Seal Plate", for gas barrier. It is installed inside the surface of the concrete wall and floor constructed underground. In operation, the seal plate is exposed to a low temperature of about -100°C, and therefore, from the viewpoint of both economy and installation, the application of steel instead of stainless steel or low temperature materials to the seal plate is very convenient. In this case, special care should be taken to the characteristics of seal plate materials at low temperatures, especially to brittle fracture characteristics. In this paper, thin mild steel plates (3.2 mm and 4.5 mm thick) were investigated for brittle fracture initiation characteristics by conducting large scale tests such as deep notch test and welded, notched wide plate test. From the results of these tests, it was proved that thin mild steel plates have excellent characteristics, such as notch toughness and brittle fraction initiation. The effect of welding residual stress on brittle fracture initiation characteristics is also discussed.

25885 Insulation system for low temperature service double wall tank. Tada, B.; Takahashi, K.; Akimoto, T.; Ishiyama, T.; Yagi, N.; Kitamura, M. *Kawasaki Giho;* No. 63, 228-233(Mar 1977). (In Japanese).

Generally speaking, the insulation system of double wall tank for LNG and other cryogenic liquids consists of a bottom insulation and a shell-roof insulation. The purpose of the bottom insulation system, formerly regarded as bearing vertical static loads, such as liquid weight and inner tank weight, has now changed in accordance with increased requirements for safety against earthquakes. As far as the shell-roof insulation is concerned, basic improvements are required today, because it is supposed to exert more undesirable mechanical effects on the tank structure, with larger and larger tanks being produced. This paper describes some results of experimental studies on our improved, safe insulation system.

25886 Development and operational experiences of LNG in-ground storage tanks in Japan. Parts I and II. Ishimasa, Y. (Tokyo Gas Co., Ltd); Umemura, J.; Fujita, A.; Rai, C. pp 38p, Session II, Paper 7 of Fifth international conference on liquefied natural gas. Volume I. Chicago; Institute of Gas Technology (1977).

From 5. international conference on liquefied natural gas; Dusseldorf, F.R. Germany (29 Aug 1977).

See CONF-770879—P1.

Following the import of LNG from Alaska and Brunei, Japan plans to start importing LNG from Das Island, Abudhabi in May 1977, and from Indonesia by the summer of 1977. Six receiving terminals have already been completed for these projects while another one is under construction. It is expected that the import of LNG to Japan will expand progressively in the future. To assure the safety of storage tanks, Tokyo Gas Company has endeavored in the development of in-ground storage tanks from long ago. After the construction of a 10,000 kl storage tank at the Negishi Works in 1970, progress has been made in the construction of large-scale in-ground storage tanks. Nine tanks are already smoothly operating at the Negishi Works and the Sodegaura Works, while the operation of three new tanks is scheduled to start by the end of this year. Osaka Gas Company started the construction of the 45,000 kl storage tank in November, 1972 and put it into operation in September, 1975. It is currently operating satisfactorily. This report presents a general outline of the design, structural aspects and gives a brief introduction on the operational experiences of the in-ground storage tanks constructed by Tokyo Gas Company, and the results of actual measurements from the operation of the in-ground storage tank constructed by Osaka Gas Company.

25887 Studies on the storage of LNG in salt cavities. Haddenhorst, H.G. (Kavernen Bau- und Betriebs GmbH, Hanover); Lorenzen, H.; Schwier, K. pp 22p, Session II, Paper 8 of Fifth international conference on liquefied natural gas. Volume I. Chicago; Institute of Gas Technology (1977).

From 5. international conference on liquefied natural gas; Dusseldorf, F.R. Germany (29 Aug 1977).

See CONF-770879—P1.

The major criteria in the evaluation of the feasibility of this type of storage system are the thermodynamic behavior of the LNG/rock system as a function of time and the change in the rock mechanics resulting from the thermal influence of the LNG. The transient temperature field around the cavity was computed and the boil-off rate was determined for a given set of operating conditions. The paper studies the rock stress field as a function of the temperature field in the cavity perimeter and the expected appearance of fractures. A 2 m^3 test cavity was leached in a salt mine and an extensive test program was carried out. The tests were made with liquid nitrogen.

25888 Tests at the FOS terminal on the LNG behavior in the big tanks. Bellus, F.; Reveillard, Y.; Bonnaure, C.; Chevalier, L. (Gaz de France, Paris). pp 20p, Session II, Paper 9 of Fifth international conference on liquefied natural gas. Volume I. Chicago; Institute of Gas Technology (1977). (In French)

From 5. international conference on liquefied natural gas; Dusseldorf, F.R. Germany (29 Aug 1977).

See CONF-770879—P1.

The determination of the recovery process of the boil-off gases of the LNG tanks and the setting of rational operating methods imply the exact knowledge of the LNG behavior during its storage. The theoretical studies carried out in this way did not allow to remove all the indeterminations so that tests have been undertaken on both 35,000 m3 tanks at FOS in order to determine particularly: the boil off rate at constant pressure of a tank for various liquid levels, evolution of the pressure of a tank entirely isolated, and the time taken for the return to the thermodynamical balance of LNG when the operating pressure of the tank is suddenly changed. Then, a simulated operation without recovery of the boil off gases has been achieved on several tanker journeys.

25889 Ultra low-temperature LNG compressors. Kato, D. (Ishikawajima-Harima Heavy Industries Co., Ltd., Tokyo). pp 16p, Session II, Paper 10 of Fifth international conference on liquefied natural gas. Volume I. Chicago; Institute of Gas Technology (1977).

From 5. international conference on liquefied natural gas; Dusseldorf, F.R. Germany (29 Aug 1977).

See CONF-770879—P1.

In 1969, the world's first ultra low-temperature compressors capable of directly drawing LNG at -160°C went into service. These machines had been perfected by Ishikawajima-Harima Heavy Industries Co. (IHI) through long years of development effort, to be installed in the first Japanese LNG storage facility attached to Tokyo Gas Co.'s Negishi Reception Terminal, located in Yokohama. Since then a large number of nonlubricated compressors of this type have been installed by IHI in LNG storage establishments in various parts of Japan. The function of these IHI Ultra Low-Temperature LNG Compressors is to directly compress to requisite pressure the boil-off gas generated in the storage tanks or during discharge from ships, without having recourse to preliminary heating of the gas, heretofore considered indispensable for this kind of service. The new design of compressors permits reliquefying the evaporated gas with minimum requirements of space, installation costs and energy consumption. The notable success obtained by IHI with the practical application of these Ultra Low-Temperature LNG Compressors promises very marked economies in installation, as well as in the operation and maintenance of LNG storage establishments.

25890 Some legal aspects of a LNG terminal establishment and operation in France. Marle, F. (Gaz de France, Paris). pp 33p, Session III, Paper 2 of Fifth international conference on liquefied natural gas. Volume II. Chicago; Institute of Gas Technology (1977). (In French)

From 5. international conference on liquefied natural gas; Dusseldorf, F.R. Germany (29 Aug 1977).

See CONF-770879—P2.

After having briefly recalled the parts played by LNG terminals, the paper sets forth the geographic situation and the main characteristics of such facilities in France. The legal system of the site occupation is surveyed, using the examples of Fos, Le Havre and Montoir de Bretagne. The main provisions of the authorizations granted to the operator are described: object, acreage, term of the concession, financial system, reasons for authorizations withdrawal, etc. The legal system of the terminal construction itself is analyzed. The operator and the relevant administrations, particularly the Port authorities, are underlined through a distinction between the contractual relationship of the partners and the legal status. The paper also deals with: the general conditions of a terminal operation; the regulations concerning liquid methane transportation and handling are looked through with a particular attention for safety, environment and liability problems; the relations between a terminal, the LNG carriers (access conditions to the terminal, unloading operations and liability) and the transport network (connecting pipe, particular servitudes); and the incidental activities of a terminal, frigories recovery and valorization, which give rise to some remarks.

OIL SHALES AND TAR SANDS

SITE GEOLOGY AND HYDROLOGY

SITE GEOLOGY

REFER ALSO TO CITATION(S) 25859

25891 Nature of straight-chain aliphatic structures in Green River kerogen. Young, D.K.; Yen, T.F. (Univ. of Southern California, Los Angeles). *Geochim. Cosmochim. Acta;* **41**: No. 10, 1411-1417(Oct 1977).

Previous studies of the Green River kerogen only provide apparently contradictory conclusions about the size of the straight-chain aliphatic structures as well as the manner in which these structures form part of the kerogen matrix. The present investigation is an attempt to resolve this contradiction. A mild stepwise oxidation procedure was followed so that extensive degradation of kerogen-derived intermediates could be prevented. Products isolated from each oxidation step were analyzed by conventional GLC techniques, GC-MS, and proton-NMR measurements in order to ascertain the significance of the straight-chain aliphatic structures present in the Green River kerogen. The following results were obtained: (a) Green River kerogen contains a substantial portion (ca 2 to 4 carbons out of every 10) of straight-chain aliphatic structures which are longer than C_4, (b) the kerogen matrix forms a three-dimensional network of non-straight-chain clusters interconnected by long polymethylene cross-links, (c) the "core," in comparison with the "periphery" of the kerogen matrix, contains a greater proportion of straight-chain and branched aliphatic structures which are attached to the kerogen matrix at one terminus, (d) some of the straight-chain structures may exist as physically entrapped components in the kerogen matrix.

25892 Stress state and hydraulic fracturing in the Athabasca Oil Sands. Dusseault, M.B. (Univ of Alberta, Edmonton). *J. Can. Pet. Technol.;* **16**: No. 3, 19-27(1977).

The geological history of the Athabasca Oil Sands suggests that the minor principal compressive stress is vertical to a depth of at least 350m. Features of natural slopes, hydraulic fracturing operations, and computer stress-strain modeling confirm the existence of higher lateral stresses in the Athabasca Oil Sands. Hydraulic fracture planes are created normal to the minor principal compressive stress direction, and are therefore horizontal above a depth of 350m, and probably vertical below a depth of 450m. Change of orientation of the minor principal stress may be brought about by fracturing operations, and in turn, this may result in an ability to control inter-well communication in areas of vertical hydraulic fracturing. 24 refs.

DRILLING, FRACTURING, AND MINING

REFER ALSO TO CITATION(S) 25892

25893 (PB—271219) **Methane absorption in oil shale and its potential mine hazard. Report of investigations 1977.** Matta, J.E.; LaScola, J.C.; Kissell, F.N. (Bureau of Mines, Pittsburgh, Pa. (USA). Pittsburgh Mining and Safety Research Center). 1977. 18p. NTIS PC A02/MF A01.

Laboratory absorption measurements on oil shale samples have shown that methane can be absorbed. The amount absorbed is proportional to pressure and oil yield, and can be much larger than would be predicted based solely on porosity. Oil shale cores collected in the field were measured for their gas content using the Bureau of Mines direct method. Cores taken from deep locations and far from outcrops yielded more gas than cores from shallower locations or at outcrops, when taking into account variations in oil yield. All data continue to indicate that oil shale mines which are both deep and far from an outcrop will emit low levels of methane gas.

OIL PRODUCTION, RECOVERY, AND REFINING

25894 Role for nuclear energy in the recovery of oil from the tar sands of Alberta. Puttagunta, V.R.; Sochaski, R.O.; Robertson, R.F.S. (At Energy of Can Ltd, pinawa, Manit). *J. Can. Pet. Technol.;* **16**: No. 3, 28-49(1977).

This report briefly describes techniques of oil recovery from the tar sands and the energy requirements of this operation. Fossil fuels, such as coal, and CANDU nuclear reactors are examined as competitive sources of energy for the tar sands plants. This study indicates the feasibility of both sources. Among the nuclear reactors, the organic-cooled version of the CANDU reactor appears to have the necessary flexibility to fit into many of the possible methods of

recovering oil from the tar sands. A strategy is discussed for the recovery of oil from the tar sands with a view to optimizing the costs and, in the long run, to conserving the fossil fuels at the expense of nuclear fuels.

IN SITU METHODS, TRUE AND MODIFIED

REFER ALSO TO CITATION(S) 25616

25895 Heavy oil sand in-situ pilot plants in Alberta (past and present). Nicholls, J.H.; Luhning, R.W. (Alberta Oil Sands Technol and Res Auth). *J. Can. Pet. Technol.;* **16**: No. 3, 50-61(1977).

This paper reviews the history of in situ pilot plant efforts toward the recovery of bitumen from the major oil sand deposits of Alberta. The review is based on published information and describes the location of the plants, the manner of operation, the estimated costs involved and the technical area under investigation. The currently operating pilot plants and future plans for new in situ pilots are also described. 50 refs.

25896 Low temperature oxidation process for the recovery of bitumen. Cram, P.J.; Redford, D.A. (Texaco Explor Can Ltd). *J. Can. Pet. Technol.;* **16**: No. 3, 72-83(1977).

A three-dimensional physical simulator was used to carry out experiments on a variety of novel processes for the in situ recovery of bitumen from the Athabasca oil sands deposit. Runs were made at up to 500 psi operating pressure. The low temperature oxidation process, comprising combinations of air and steam, was shown on the basis of the laboratory data to be a most promising recovery technique. The paper compares the performance of the low temperature oxidation process with a straight steam displacement process and describes the factors which determine the optimum performance and the mechanisms which are believed to contribute to the effectiveness of the process. 13 refs.

25897 Oil sands in situ projects continue at impressive rate. Malden, M.L. *Energy Process./Can.;* **70**: No. 1, 24-26, 28-30, 32, 34(1977).

In-situ research and pilot plant recovery projects continue to set the pace in experimental efforts to exploit the massive in-place reserves of Alberta's four major tar sands deposits. The projects include five active projects in the Athabasca deposit, eight current projects in the Cold Lake deposit, and one field investigation each in the Peace River and Wabasca deposits to make a total of 15 active projects with more than 266 test wells. (DLC)

25898 In situ recovery process for the oil sands of Alberta. Giguere, R.J. (Amoco Canada Petroleum Co. Ltd., Calgary, Alberta). *Energy Process./Can.;* **70**: No. 1, 36-40(1977).

This paper reviews Amoco Canada's past 20 years of research effort in the laboratory and in the field. Discussed are the six phases of field work undertaken and resultant in situ recovery processes developed. Results are: a successful producing well completion, a successful air injection well completion, a heat and corrosion resistant alloy, and developed thermal stimulation techniques for the producing wells. A three-step in-situ process is foreseen for the recovery of the Athabasca bitumen: a pre-heat phase via forced forward combustion with injection above overburden pressures, a blowdown phase, and COFCAW (combination of forward combustion and waterflood) displacement phase. (DLC)

REFINING

25899 Hydrovisbreaking of Athabasca bitumen and its reaction mechanism. Tominaga, H.; Itoh, S.; Yashiro, M. (Univ of Tokyo, Jpn). *Bull. Jpn. Pet. Inst.;* **19**: No. 1, 50-55(May 1977).

Athabasca bitumen was subjected to thermal cracking at temperatures of 430-520 C in the presence of hydrogen at 50 atm. A significant decrease in viscosity and in the average molecular weight of the bitumen were attained without excessive coke formation. The reaction mechanism is discussed based on the detailed structural analyses of the bitumen and the oil cracked by visbreaking by use of the various methods including GPC, NMR, and elemental analysis. 5 refs.

PROPERTIES AND COMPOSITION

REFER ALSO TO CITATION(S) 25668, 25899

25900 Chemical composition of athabasca bitumen. Selucky, M.L.; Chu, Y.; Ruo, T.; Strausz, O.P. (Univ of Alberta, Edmonton). *Fuel;* **56**: No. 4, 369-381(Oct 1977).

A detailed analysis has been carried out on the deasphaltened Athabasca bitumen using two different series of chromatographic separations followed by i.r., u.v., n.m.r. and computerized GC/MS studies. The separated fractions, saturates, monocyclic and dicyclic aromatics were subjected to high-voltage, low-resolution mass spectrometric analysis. The saturate fractions were also examined for geochemical markers. 27 refs.

DIRECT USES AND BY-PRODUCTS

25901 Problems of energy utilization of bituminous shale. Epik, I.P. (Est SSR Acad of Sci). *Izv. Vyssh. Uchebn. Zaved., Energ.;* No. 4, 54-61(Apr 1977). (In Russian).

Problems of development of energy utilization of combustible shale in the USSR, problems of design of shale-fired boilers, of emissions of shale-fueled power plants, of complex utilization of shale, burnt in the form of pulverized fuel, and of complex utilization of shale for energy and technological purposes are considered. So far, there exist two big power plants in Estonia burning Estonian shale. No substantial expansion of energy use of shale is envisaged in the USSR in the 1976-1980 period. It is envisaged, however, to expand shale ash utilization for agricultural soil liming and for the production of building materials. Likewise, it is planned to put into service a large pilot industrial plant for energy and technological processing of shale at the Estonian district power plant.

ENVIROMENTAL ASPECTS

25902 (EPA—600/9-77-033) Oil shale and the environment. (Environmental Protection Agency, Washington, D.C. (USA). Office of Research and Development). Oct 1977. 33p. NTIS.

The environmental effects of oil shale exploitation are evaluated and government actions to ensure that shale development does not become an intolerable environmental burden are discussed. The discussions are presented in sections on the oil shale resource, recovery processes, environmental effects, oil shale research and development, and resource development forecasts. (JRD)

NUCLEAR FUELS

RESERVES

25903 (LA-UR—77-2863) Possible uranium—ruthenium method for measurement of ore age. Maeck, W.J.; Apt, K.E.; Cowan, G.A. (Los Alamos Scientific Lab., N.Mex. (USA)). 1977. Contract W-7405-ENG-36. 7p. (CONF-771222—3). Dep. NTIS, PC A02/MF A01.

From IAEA symposium on natural fission reactors; Paris, France (19 Dec 1977).

A technique has been devised to date Precambrian uranium ore samples by measuring the concentrations of ^{238}U and of ruthenium isotopes that result from the spontaneous fission of ^{238}U. The concentration of the latter depends on (1) the amount of ^{238}U present, (2) the spontaneous fission decay rate, (3) the ruthenium fission yields for ^{238}U, and (4) the duration of spontaneous fission, i.e., the age of the ore. Ruthenium in Precambrian ores has been identified as being from the natural abundance, the spontaneous fission of ^{238}U, and the more variable neutron-induced fission of ^{235}U. The contribution from "common" natural ruthenium is typically 1 ppB and is determined from the isotopes of mass 96, 98, and 100, which are not produced in fission. The ratio of isotopes of mass 99, 101, 102, and 104 for ^{238}U spontaneous fission has been found to be significantly different from that ratio for ^{235}U neutron-induced fission. Hence, the amount of ruthenium in an ore sample which results solely from ^{238}U spontaneous fission can be determined. Several Precambrian uranium ore samples have been dated using this technique, and the ages compare favorably to values determined by other techniques. The component of ruthenium resulting from neutron-induced fission of ^{235}U varied between about 5 and 50 percent of the amount from ^{238}U spontaneous fission, and the component of common ruthenium was typically about 25 percent of the total ruthenium. This uranium—ruthenium technique should complement existing radiogenic dating techniques because it relies on a radiogenic product whose geochemistry is different from that of products or intermediates in the other decay sequences.

25904 Hydrogen - a reducing agent in some uranium deposits. Levinson, A.A. (Calgary Univ., Alberta (Canada). Dept. of Geology). *Can. J. Earth Sci.;* **14**: No. 11, 2679-2681(Nov 1977).

Hydrogen, a strong reducing agent, may have been active in certain uranium deposits for which no other reducing agent has been found or may be inferred. The mechanisms that produce hydrogen in several geological environments are described. These include hydrogen generated near the surface by hydrogen-producing bacteria, at

depth from magmatic sources, and from metamorphism of graphite-containing rocks.

25905 Investigation of uranium-1 and uranium-containing minerals by luminescence spectra. Gorobets, B.S.; Engonyan, S.S.; Sidorenko, G.A. *At. Energ. (USSR);* **42**: No. 3, 177-182(Mar 1977). (In Russian).

The electron-vibrational luminescence spectra of 15 uranium minerals and 4 minerals containing uranium impurities at 77 and 298 K have been determined. Standard spectra of uranyl minerals make it possible to quickly diagnose. Luminescence spectra of nonuranium minerals make it possible to recognize the basic forms in which uranium enters host minerals: aqua-complexes of uranyl in silica minerals and finely dispersed phases of uranium minerals (ursilites) in calcites. With decreasing chemical-bond multiplicity in uranyl as a result the frequency of symmetric vibration decreases and the colour of luminescence shifts from blue-green to the red-orange part of the spectrum as the anion component of the uranyl minerals changes.

25906 Potassium—sodium metasomatites of a hydrothermal, uranium—molybdenum ore deposit. Petrosyan, R.V.; Buntikova, A.F. *Izv. Akad. Nauk SSSR, Ser. Geol.;* No. 1, 74-81(Jan 1977). (In Russian).

A look is taken at the structure and formation conditions of an aureole in a uranium-molybdenum deposit with near-mineral, altered ores containing simultaneously potassium and sodium aluminosilicates (hydromica and albite). A spacial and time relation is established for mineral associations at separate stages of ore formation with definite kinds of altered ores. 2 figures, 1 table, 5 references. (SJR)

EXPLORATION

REFER ALSO TO CITATION(S) 25729

25907 (LA—7128-MS) **Data management and handling for the Hydrogeochemical and Stream Sediment Reconnaissance program at the Los Alamos Scientific Laboratory.** Cheadle, J.M. Jr. (Los Alamos Scientific Lab., N.Mex. (USA)). Jan 1978. Contract W-7405-ENG-36. 4p. (GJBX—22(78)). Dep. NTIS, PC A02/MF A01.

Since the spring of 1975, the Energy Systems and Statistics Group (Q-12) at the Los Alamos Scientific Laboratory (LASL) has been involved in the data management aspects of the National Uranium Resource and Evaluation (NURE) Hydrogeochemical and Stream Sediment Reconnaissance (HSSR) program. The HSSR program is administered at LASL by the Geochemical Applications Group (G-5). This report is a description of the data management performed for G-5.

25908 Pulsed neutron generator for logging. Thibideau, F.D. (General Electric Co., St. Petersburg, FL). *Log Anal.;* **18**: No. 6, 12-16(1977).

A pulsed neutron generator for uranium probe logging has been developed by the General Electric Neutron Devices Department for Sandia Laboratories, Albuquerque. The generator is part of a prototype uranium logging probe being developed to detect, and assay, uranium by borehole logging. The logging method is based on the measurement of epithermal neutrons resulting from the prompt fissioning of uranium from a pulsed source of 14 MeV neutrons. One objective of this prototype probe is that its diameter not exceed 2.75 inches, which would allow its use in conventional rotary drill holes of 4.75-inch diameter. This restriction limited the generator to a maximum 2.375-inch diameter. The performance requirements for the neutron generator specified that it operate with a nominal output of 5×10^6 neutrons/pulse at up to 100 pulses/second for a one-hour period. The development of a neutron generator meeting the preliminary design goals was completed and two prototype models were delivered. These two generators have been used to log a number of boreholes in field evaluation of the probe. The results have led to the recommendation of several changes to improve the probe's operation. Some of these changes will require additional development effort on the neutron generator. This report describes the design and operation of the first prototype neutron generators.

25909 Geophysical techniques used in uranium exploration. Meyer, P.A. (Rocky Mountain Energy Co., Denver). pp 305-310 of Exploration frontiers of the central and southern Rockies. Veal, H.K. (ed.). Denver; Rocky Mountain Association of Geologists (1977).

From Symposium program RMAG fall field conference; Snowmass, CO, USA (29 Sep 1977).

See CONF-770972—.

The impetus in uranium exploration has been generated by the increase in price to about $40.00 a pound or $2.50 an ounce, a price that approaches a precious metal. Not only has the search increased in the traditional sandstone areas, but also in the igneous and metamorphic environments. Because uranium is one of the elements along with thorium and potassium that radiate alpha, beta and gamma rays; direct methods have been developed and improved upon to measure this radiation while indirect traditional geophysical methods have been used to assist in locating associated favorable structural and "stratigraphic" zones.

25910 Geology of uranium deposits in the Madison Limestone Little Mountain area, Big Horn County, Wyoming. McEldowney, R.C. (Dames and Moore, Denver); Abshier, J.F.; Lootens, D.J. pp 321-336 of Exploration frontiers of the central and southern Rockies. Veal, H.K. (ed.). Denver; Rocky Mountain Association of Geologists (1977).

From Symposium program RMAG fall field conference; Snowmass, CO, USA (29 Sep 1977).

See CONF-770972—.

Uranium deposits in the Mississippian-age Madison Limestone occur in caves and in solution channels in the upper 200 feet of the unit as thin-bedded clays and silts, and as dissemination and crusts in the limestone breccia. Geologic mapping of surface exposures, mapping of the underground mines, geochemical and geophysical exploration, and drilling on Little Mountain in north-central Wyoming have revealed the presence of subsurface cave systems which appear to be interconnected along fault zones. Initial cave formation occurred during a period of karst development in post-Madison, pre-Amsden time, in conjunction with extensive solutioning of an evaporite sequence within the upper 400 feet of the limestone. Secondary cave development took place along Laramide fault and joint zones, and involved excavation of older caves, followed by the formation of channelways along weak zones in the down-dip directions. In Plio-Pleistocene time, uranium mineralization was introduced into the cave systems during periods when terraces were being developed by the Big Horn River. The uranium may have been deposited in the larger caves by thermal springs, and accumulated as black organic muds on the cave floors, in speleothems and in the limestone breccia along active hydrologic systems.

25911 Uranium deposits of the Grants mineral belt: geochemical constraints on origin. Brookins, D.G. (Univ. of New Mexico, Albuquerque). pp 337-352 of Exploration frontiers of the central and southern Rockies. Veal, H.K. (ed.). Denver; Rocky Mountain Association of Geologists (1977).

From Symposium program RMAG fall field conference; Snowmass, CO, USA (29 Sep 1977).

See CONF-770972—.

A polygenetic origin of the uranium deposits of the Grants mineral belt is consistent with geologic and geochemical evidence. The characteristic suite of elements associated with uranium from distant source areas, viz. V, Mo, Se, As, indicates processes for deposition similar to those for Wyoming and Texas roll types of deposits, except that the rates of deposition were probably more dynamic thus leading to primary ore body geometries described as trend ore. Organic matter is associated with the ore and was important for both transport and precipitation; directly by providing reductants in addition to sulfide: sulfate redox reactions, and indirectly by promoting attack on allogenic rock forming and early formed diagenetic clay minerals. The trend ore in the Ambrosia Lake district and Smith Lake area is very nearly syngenetic; recent Rb-Sr age determinations yield ages of mineralization for coffinite-chlorite-organic carbon-pyrite assemblages of 135 +- 10 My as opposed to age of sedimentation for barren host rock of 145 +- 10 My. Only in the Jackpile-Paguate area are ages of mineralization quite different, i.e., 110-115 My. The Rb-Sr data also reveal for the Ambrosia Lake-Smith Lake areas Precambrian source materials and Permian—Triassic source material; both of which provided U to the Grants mineral belt. The trace element suites from ore zones, oxidized rocks near ore, and both oxidized and reduced rocks removed from ore suggest that the upper units of the Morrison Formation (i.e., Brushy Basin Member) contained volcanic detritus which provided not only U, V, Mo, Se, As but other trace elements which are not usually transported far from their sites of origin; viz. rare earth elements, Th, Ta, Sb.Thus a polygenetic model similar to the roll-type mechanisms but involving more complex sedimentary control and U from several source areas is compatible with the trend and other ore in the Grants mineral belt.

25912 Uranium abundance in some Precambrian and Phanerozoic rocks from New Mexico. Brookins, D.G.; Della Valle, R.S. (Univ. of New Mexico, Albuquerque). pp 353-362 of Exploration frontiers of the central and southern Rockies. Veal, H.K. (ed.). Denver; Rocky Mountain Association of Geologists (1977).

From Symposium program RMAG fall field conference; Snowmass, CO, USA (29 Sep 1977).

See CONF-770972—.

The uranium abundance in both Precambrian and Phanerozoic rocks of New Mexico is of interest because of the uranium resources of the state and problems associated with provenance, possible low grade resources, and related topics. For this study approximately 100 Precambrian igneous, 25 Precambrian metamorphic, 135 Paleozoic and Mesozoic sedimentary, and 30 Tertiary and

Quaternary volcanic rocks have been analyzed for their uranium content by delayed neutron activation analysis (DNAA). The DNAA method is much more precise and accurate than standard gamma counting techniques for samples which contain less than 50 ppM uranium and thus is the preferred method for the study of most non-ore rocks. The data indicate a mean of 3.33 ppM U for Precambrian igneous rocks, 1.20 ppM U for Precambrian metamorphic rocks, and a wide range in U values for the Jurassic Morrison Formation with samples from unmineralized units ranging from less than 1 to 30 ppM with means ranging from 3 ppM (sandstones) to 7 or 9 ppM (shales). The Permian Madera Formation yields a mean of 5.65 ppM and the Cretaceous Dakota and Mancos Formations yield means of 5 and 4 ppM respectively. Collectively, the data argue for abundant uranium in Precambrian rocks and for younger uranium mineralization or sub-economic fixation in Phanerozoic rocks, some of which may have provided uranium to mineralized zones. The uranium content of young volcanic rocks supports the hypothesis that the rocks of the Colorado Plateau are indeed enriched in uranium relative to peripheral areas.

25913 Instruktsiya po gamma-karotazhu pri poiskakh i razvedke uranovykh mestorozhdenij. (Manual on gamma logging in search and exploration of uranium deposts). Moscow; Ministerstvo Geologii SSSR (1974). 108p. (In Russian).

A number of studies on gamma logging of boreholes in the search for and exploration of uranium deposits, using scintillation equipment of the ZOND, VITOK-2, and AGAT-69 types, are described. Preparation of the apparatus and equipment, techiques of constructing gamma logs, and methods for quantitative interpretation of the results using electronic calculating machines and graphic methods are described. The observation of all the instructions given will ensure that the initial data for calculating uranium reserved within permissible errors are obtained.

MINING

25914 Chemical factors in in-situ uranium leach mining. Galichon, P.; Schechter, R.S.; Cowley, A.; Breland, M. (Univ of Tex, Austin). *In Situ;* **1**: No. 2, 125-146(1977).

The effect of varying flow rate, oxidant type and concentration, and techniques of pretreatment on the efficiency of in-situ uranium extraction has been studied. These tests, conducted in a packed tubular reactor, revealed that within the range of flow rates studied, the uranium extracted as a function of volume injected did not vary. This was interpreted to imply that the dissolution rates were mass transfer limited. Hydrogen peroxide was found to be a more effective oxidant than sodium perchlorate, but peroxide rapidly decomposed to form oxygen and water. Thus oxygen saturated leachant should be as effective. 9 refs.

FEED PROCESSING

REFER ALSO TO CITATION(S) 26840

ENRICHMENT

25915 (ID—75-45) **Allocation of uranium enrichment services to fuel foreign and domestic nuclear reactors.** (General Accounting Office, Washington, D.C. (USA)). 4 Mar 1975. 34p. (B—181963). Accounting Office, Washington, DC $1.00.

This interim report was made in response to a request for information concerning the sale of U.S. uranium enrichment services to foreign countries and its effect on AEC's ability to meet domestic demands. Long-term enrichment services (June 30, 1974), both domestic and foreign, totaled 364,000 MW, or 44,000 MW more than its available capability. The first-come-first-served policy was modified to give preferential treatment to Yugoslav and Mexican requests because of IAEA commitments, and to shift six standard contracts from Japan. From Aug. to Sept. 1974, standard contracts were signed for all 15 pending domestic requests and for 33 pending foreign requests, with the remaining 45 foreign requests depending on NRC's approval of Pu recycle, although private enrichment or stockpile enriched U could meet these needs. There is no firm commitment in the private sector to build and operate the needed enrichment plant. The acceleration of foreign nuclear programs coupled with ERDA's termination of further long-term contracts, may lead to the emergence of foreign supply sources, and U.S. may lose its favorable balance-of-payments and its influence on international nuclear policies. (DLC)

25916 Update on uranium enrichment in South Africa. An overview of the uranium scene in the Republic. *Prof. Eng. (Pretoria);* **6**: No. 4, 17, 19(Oct 1977).

One of the most notable achievements of the South African Atomic Energy Board was the development of a viable process for the enrichment of natural uranium, that is, a process to increase the percentage of the fisionable uranium isotope ^{235}U from 0,71% as it occurs in natural uranium, to a value of for example 3%, for use as a nuclear fuel in power reactors. Shortly after the announcement of the process in 1970, the Uranium Enrichment Corporation of South Africa was formed to further develop and exploit the process. By nature of the subject, information on the separation process has largely remained classified, but some data was released in two recent publications. This information forms the basis of the present review.

25917 French research in the field of uranium enrichment. *Rev. Gen. Nucl.;* No. 3, 230-233(May-Jun 1977). (In French).

The various uranium enrichment procedures studied in France, and particularly in the C.E.A., are analyzed jointly from the point of view of the evolution in their technical and economical performance, and of the risks of proliferation which are involved.

GASEOUS DIFFUSION

REFER ALSO TO CITATION(S) 26821

LASER EXCITATION

25918 Optimum operating conditions for a laser uranium enrichment plant. Yamada, K.; Ozaki, N. (Hitachi Ltd., Kawasaki, Kanagawa (Japan). Atomic Energy Research Lab.); Yamamoto, M.; Ueyanagi, K. *Appl. Phys.;* **3**: No. 4, 287-306(Oct 1977).

Operating conditions of the laser uranium enrichment plant to obtain cheaper enriched uranium are optimised by using the standard optimisation procedure. A simple kinetic model is given to obtain the ion production rate as a function of the laser energy density, ultraviolet light energy density, atomic density and depth and height of the reaction region. The unit cost of enriched uranium is chosen as a value function instead of the unit cost of the separative work. The construction cost is expressed by means of an exponential function to take the scale merit into account. Two numerical results are given. In case 1, the laser power and efficiency are subject to the restraints determined by the present technical levels and in case 2, they are free. The unit cost of the enriched uranium is higher than those of the gaseous diffusion and gas centrifuge methods by a factor of 2 approximately 11. Results indicate that laser uranium enrichment is probably competitive with the other uranium enrichment methods, provided that the laser efficiency is improved by up to 1% and the laser lifetime is extended several times.

25919 Optimum operating conditions for a laser uranium enrichment plant. Yamada, K.; Ozaki, N.; Yamamoto, M.; Ueyanagi, K. (Hitachi, Ltd, Kanagawa, Jpn). *Appl. Energy;* **3**: No. 4, 287-311(Oct 1977).

Operating conditions of the laser uranium enrichment plant to obtain cheaper enriched uranium are optimized by using the standard optimization procedure. A simple kinetic model is given to obtain the ion production rate as a function of the laser energy density, ultraviolet light energy density, atomic density, and depth and height of the reaction region. The unit cost of enriched uranium is chosen as a value function instead of the unit cost of the separative work. The construction cost is expressed by means of an exponential function to take the scale merit into account. Two numerical results are given which indicate that laser uranium enrichment is probably competitive with the other uranium enrichment methods, provided that the laser efficiency is improved by up to 1% and the laser lifetime is extended several times.

25920 Cost analyses of uranium enrichment by laser isotope separation process. Ozaki, N.; Yamada, K. (Hitachi Ltd., Kawasaki, Kanagawa (Japan). Atomic Energy Research Lab.); Yamamoto, M.; Tomiyama, S.; Ueyanagi, K. *Appl. Phys.;* **8**4: No. , 9-294(Oct 1976).

The probability of the selective two-step photoionisation of ^{235}U atoms by laser and ultraviolet radiations is estimated from the rate equations for uranium atoms with two isotopes with three levels. The population of ^{235}U ions is obtained by linearising the rate equations. The ion production rates have been calculated for three cases in which the laser and ultraviolet powers are changed while the atom density is kept constant. The power consumption and the capital investment required for the large-scale laser enrichment plant conceptionally designed based upon the above results, and consequently the unit cost of separative work, are estimated. It is concluded that the laser isotope separation process could be competitive with the conventional gaseous diffusion and gas centrifugal methods.

FUELS PRODUCTION AND PROPERTIES

REFER ALSO TO CITATION(S) 26661

25921 Method of making nuclear fuel bodies. Davis, D.E.; Leary, D.F. (to General Atomic Co.). US Patent 4,035,452. 12 Jul 1977. Filed date 21 Jan 1975. 6p.

A method of making nuclear fuel bodies is described comprising: providing particulate graphite having a particle size not greater than about 1500 microns; impregnating the graphite with a polymerizable organic resin in liquid form; treating the impregnated particles with a hot aqueous acid solution to pre-cure the impregnated resin and to remove excess resin from the surfaces of said graphite particles; heating the treated particles to polymerize the impregnant; blending the impregnated particles with particulate nuclear fuel; and forming a nuclear fuel body by joining the blend of particles into a cohesive mass using a carbonaceous binder.

SPENT FUELS REPROCESSING

REFER ALSO TO CITATION(S) 26667, 26840

25922 Uranium geochemical prospecting in Salzburg Province, Austria. Smith, A.Y.; Cameron, J.; Barretto, P.M.C. (Int At Energy Agency, Vienna, Austria). *Berg- Huettenmaenn. Monatsh.;* **122**: No. 8, 304-315(Aug 1977).

Surveying methods including stream sediment and water sampling, gamma-ray spectrometry, geochemical analysis for uranium and computer processing of geochemical data and results of the various geochemical techniques employed in the survey are discussed. It was found that at the reconnaissance level, determination of uranium in surface waters offers a cheap and rapid method of outlining areas of interest for further studies. At the follow-up level stream sediment sampling directed attention to several interesting areas not previously known. Results indicatre that major dispersion of uranium takes place in solution.

TRANSPORT AND STORAGE

25923 Statistical analysis of low-radiation packages in the transport of radioactive material. Failla, L. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). *Health Phys.;* **33**: No. 3, 183-189(Sep 1977).

A sample of 39,645 packages containing radioactive materials that were transported in Italy in 1974 is examined. About 35% of these are low-level radiation sources and fall into 'Category I-white' in the IAEA Regulations for the Safe Transport of Radioactive Materials. A statistical analysis is made of the radioisotopes and quantities contained, and the dose risks in accidents from irradiation and contamination are estimated. It appears that the subsequential dose risk contribution is derived only from contamination. About 75% of the 14,048 packages considered give a dose risk greater than 1 rem under the assumptions made. To be more realistic, a reduction factor of 10^6 is possible, if only 10^{-3} of the total content is released and only 10^{-3} of that released, is taken up by a single individual. Results are discussed in relation to the 'exempted' quantities of IAEA's Regulations. It is concluded that it is possible to examine reducing with all appropriate caution, the conditions for transport of 'White I' category packages.

25924 Plant for decanting strongly radioactive resins in waste containers. Hempelmann, W.; Waldenmeier, G. (to Kernforschungszentrum Karlsruhe (Germany, F.R.)). German(FRG) Patent 2,526,424/A/. 30 Dec 1976. 15p. (In German).

An improvement is proposed for plants for decanting strongly radio-active resins, which occur in nuclear power plants, which should have the effects of increasing the leak-tightness, of reducing the water consumption, and of making the equipment more economical as it has no moving parts which can wear. The plant consists of a supply container, an intermediate storage container, and a waste barrel, which are all connected by a pipework system in which the resin is transported at sub-pressure. Details of the technical construction are described.

MARKETING AND ECONOMICS

REFER ALSO TO CITATION(S) 25722

25925 Can world meet 300,000 tonnes supply challenge. Marshall, P. *Nucl. Eng. Int.;* **22**: No. 264, 35-37(Nov 1977).

Some of the preliminary findings of a Candian study on world nuclear resources are reported. The level of demand for uranium and requirements to meet it are examined to the year 2020. A number of scenarios covering a wide range of nuclear growth possibilities and the uranium requirements for each of these, are considered. It is concluded that nuclear energy could not supply, by 2020, even 50% of the world demand for electricity without employing various advanced fuel cycles.

WASTE MANAGEMENT

REFER ALSO TO CITATION(S) 25943, 25944, 25945, 25946, 25947, 25948, 25949, 25950, 25951, 25952

25926 (NP—23021) **Considerations of environmental protection criteria for radioactive waste. Background report.** (Environmental Protection Agency, Washington, D.C. (USA). Office of Radiation Programs). Feb 1978. 64p. Protection Agency, Washington, DC.

Development of environmental protection requirements for radioactive wastes basically involves: (1) features of radioactive materials that require them to be designated as radioactive wastes and their hazard potential over time and at various levels of controls, (2) the importance of risk estimates in arriving at levels of control and the factors that should be reflected in such determinations, (3) the goals of control and the types of institutional, engineered, and natural-barrier controls for meeting such goals, (4) the approaches for determining the allowable levels of short- and long-term risks associated with various means of disposal for types of waste materials, and (5) other considerations for environmental protection such as retrievability, monitoring, and transfer of information to succeeding generations. This background report addresses these five areas in sequence in order to make recommendations for environmental protection criteria which are to be used in the development of environmental standards for major classes of radioactive waste.

25927 Development of an installation for safe disposal of concentrated liquid radioactive wastes of nuclear power plants. Liptak, L.; Takach, F. (Inst ERETERB, Budapest, Hung). *Teploenergetika (Moscow);* No. 5, 87-89(May 1977). (In Russian).

Methods of safe disposal of liquid radioactive wastes of nuclear power plants, in particular those now being developed in Hungary, are described. A large pilot industrial plant with the capacity of 15 m^3, for evaporation concentration of liquid wastes, is described. The concentration tank has one wall, but a double-walled tank is to be built in the future.

WASTE PROCESSING

25928 (DPST—75-426-TL) **Conceptual process for conversion of high level waste to glass.** (Du Pont de Nemours (E.I.) and Co., Aiken, S.C. (USA). Savannah River Lab.). 7 Aug 1975. Contract EY-76-C-09-0001. 25p. NTIS, MF A01.

Portions of document are illegible.

During a ten-year period highly radioactive wastes amounting to 22 million gallons of salt cake and 5 million gallons of wet sludge are to be converted to 1.2 million gallons of glass and 24 million gallons of decontaminated salt cake and placed in the new storage facilities which will provide high assurance of containment with minimal reliance on maintenance and surveillance. The glass will contain nearly all of the radioactivity in a form that is highly resistant to leaching and dispersion. The salt cake will contain a small amount of residual radioactivity. The process is shown in Figure 1 and the facilities may be arranged in seven modules to accomplish seven tasks, (1) remove wastes from tanks, (2) separate sludge and salt, (3) decontaminate salt, (4) solidify and package sludge and ^{137}Cs, (5) solidify and package decontaminated salt, (6) store high level waste, and (7) store decontaminated salt cake.

25929 Procedure for purifying a filter column. Schwarz, H.; Sitter, H. (to Kraftwerk Union A.G., Muelheim an der Ruhr (Germany, F.R.)). German(FRG) Patent 2,513,427/B/. 20 Jan 1977. 3p. (In German).

The amounts of contaminated activated carbon found in the filters of nuclear power stations may be easily disposed of by burning the activated carbon in the filter column. The combustion temperature may be controlled by dosed admission of air or nitrogen. The C0 and $C0_2$ thus produced are discharged into the high atmosphere by means of a waste stack, and only the solid residues (about $^1/_{100}$ of the initial amount) are brought to final storage. The plant and its operation are described.

25930 Techniques for the solidification of high-level wastes. Vienna; IAEA (1977). 122p.

The problem of the long-term management of the high-level wastes from the reprocessing of irradiated nuclear fuel is receiving world-wide attention. While the majority of the waste solutions from the reprocessing of commercial fuels are currently being stored in stainless-steel tanks, increasing effort is being devoted to developing technology for the conversion of these wastes into solids. A number of full-scale solidification facilities are expected to come into operation in the next decade. The object of this report is to survey and compare all the work currently in progress on the techniques available for the solidification of high-level wastes. It will examine the

high-level liquid wastes arising from the various processes currently under development or in operation, the advantages and disadvantages of each process for different types and quantities of waste solutions, the stages of development, the scale-up potential and flexibility of the processes.

25931 Improvement on removal of radio-cobalt from waste water by ferric hydroxide coagulation-flocculation process using diethyldithiocarbamate. Motojima, K.; Katsuyama, K.; Yamazaki, Y. (Japan Atomic Energy Research Inst., Oarai, Ibaraki. Oarai Research Establishment). *Ann. Nucl. Energy;* **4**: No. 9, 453-456(1977).

By adding a small amount of sodium diethyldithiocarbamate (Na-DDTC) in the ordinary decontamination process of low-level radioactive waste water by ferric hydroxide coagulation-flocculation, removal of radio-cobalt is remarkably improved. The quantity of Na-DDTC used is only 10 ppm in concentration, which does not affect the decontamination process, and no DDTC is detected in the treated water. High decontamination factors for radio-cobalt of 80 to 100 are obtained for the waste water containing 10^{-4} μCi/ml level of radio-cobalt, and the values are about five times that without DDTC.

25932 Evolution of radwaste evaporators in West Germany. Mende, H.; Freeze, H.L. (Luwa-SMS, Butzbach, Ger). *Am. Soc. Mech. Eng., [Pap.]*: No. 77-JPGC-NE-13, vp(1977).

Radwaste evaporator installations at West German research centers and nuclear power stations include: thin-film evaporators, "pot still" evaporators, natural circulation evaporators, and forced circulation evaporators. It has been found that the activity of the distillate is decreased by reducing the entrainment of liquid droplets carried from the evaporator to the condenser by the rising water vapor. Entrainment separators and packed columns above an evaporator have lower decontamination factors than tray columns which "scrub" entrainment from the vapor by partial reflux of the distillate. Measurements on operating radwaste evaporators demonstrate that effective vapor scrubbing is dependent on tray design, the specific radionuclide, the reflux ratio, and the pH of the liquid phase on the tray. Corrosion in evaporators has been virtually eliminated by the proper selection of materials of construction, pH control, and evaporator operating philosophy.

25933 Procedure and device for decontaminating radioactive waste waters. German(FRG) Patent 2,460,872/A/. 4 Nov 1976. 9p. (In German).

The decontamination of waste water containing short-lived radioactive materials, e.g. faecal waste water from hospitals with nuclear-medicine departments, takes place via decay plants. It is proposed that flow channeling of such plants should be arranged so that multiple mixing is carried out. This prevents single parts 'shooting through' too quickly and not dwelling for long enough. Turbulence can be achieved by blowing in air. A plant giving good results is described.

25934 Concentration of aqueous radioactive waste with wiped-film evaporators. Goodlett, C.B. (Savannah River Lab., Aiken, SC). *AIChE Symp. Ser.;* **72**: No. 154, 111-122(1973).

Tests at the Savannah River Laboratory with two small wiped-film evaporators show that synthetic alkaline (Purex) waste can be converted to a free-flowing slurry that solidifies upon cooling to ambient temperature. The desired concentration can be obtained in one pass rather than the several passes required with the bent-tube evaporators presently used at the Savannah River Plant.

WASTE DISPOSAL AND STORAGE

25935 (BNWL—1997) Public values associated with nuclear waste disposal. Maynard, W.S.; Nealey, S.M.; Hebert, J.A.; Lindell, M.K. (Battelle Human Affairs Research Center, Seattle, Wash. (USA)). Jun 1976. Contract EY-76-C-06-1830. 181p. Dep. NTIS, PC A09/MF A01.

This report presents the major findings from a study designed to assess public attitudes and values associated with nuclear waste disposal. The first objective was to obtain from selected individuals and organizations value and attitude information which would be useful to decision-makers charged with deciding the ultimate disposal of radioactive waste materials. A second research objective was to obtain information that could be structured and quantified for integration with technical data in a computer-assisted decision model. The third general objective of this research was to test several attitude-value measurement procedures for their relevance and applicability to nuclear waste disposal. The results presented in this report are based on questionnaire responses from 465 study participants. (LK)

25936 (DP-MS—77-115) Compatibility testing of vitrified waste forms. Rankin, W.N. (Du Pont de Nemours (E.I.) and Co., Aiken, S.C. (USA). Savannah River Lab.). 1978. Contract EY-76-C-09-0001. 16p. (CONF-780308—5). Dep. NTIS, PC A02/MF A01.

From NACE meeting on corrosion; Houston, TX, USA (6 Mar 1978).

The compatibility of vitrified radioactive waste with candidate canister materials will be evaluated with both cast and in-can melted vitrified waste. Both real and simulated sludges will be used. In addition, the compatibility of these materials with salt from a possible final storage location will be determined. Cast vitrified waste will be tested with ASTM A 333 and ASTM A 516 low-carbon steels and Type 304L stainless steel at 100, 600 and 800°C. Cast vitrified waste that has been devitrified by heat treatment will be tested at 100°C. Two types of test specimens will be used with either simulated or real sludges: (1) unsealed capsules made of pieces of mill-finished pipe into which vitrified waste is cast, and (2) sealed capsules containing a small container of vitrified waste identical to the ones in the unsealed capsule. In-can melted vitrified waste will be tested with synthetic sludge only and with ASTM A 333 and ASTM A 516 low-carbon steels, Type 304L stainless steel and Inconel 600. Two types of tests will be carried out: (1) melting vitrified waste in miniature metal canisters and (2) exposure of small (carefully measured) metal coupons to molten glass. The air oxidation rates of candidate canister materials will be determined, and specimens will also be exposed to salt from Drill Hole AEC-8 in Carlsbad, New Mexico. Sealed capsules containing an ASTM A 516 low-carbon steel or Type 304L stainless steel specimen partially embedded in a small block of salt will be heated.

25937 (LBL—7004) Appraisal of hard rock for potential underground repositories of radioactive wastes. Cook, N.G.W. (California Univ., Berkeley (USA). Dept. of Materials Science and Engineering). Oct 1977. Contract W-7405-ENG-48. 17p. Dep. NTIS, PC A02/MF A01.

The mechanical safety and stability of such an underground repository depends largely on the virgin state of stress in the rock, groundwater pressures, the strengths of the rocks, heating by the decay of the radioactive wastes, and the layout of the excavations and the disposition of waste cannisters within them. A large body of pertinent data exists in the literature, and each of these factors has been analyzed in the light of this information. The results indicate that there are no fundamental geological nor mechanical reasons why repositories capable of storing radioactive wastes should not be excavated at suitable sites in hard rock. However, specific tests to determine the mechanical and thermal properties of the rocks at a site would be needed to provide the data for the engineering design of a repository. Also, little experience exists of the effects on underground excavations of thermal loads, so that this aspect requires theoretical study and experimental validation. The depths of these potential repositories would lie in the range from 0.5 to 2.0 km below surface, depending upon the strength of the rock. Virgin states of stress have been measured at such depths which would retard the ingress of groundwater and obviate the incidence of faulting. A typical repository comprising three horizons each with a total area of 5 km^2 would have the capacity to store wastes with thermal output of 240 MW.

25938 (ORNL/EIS—115) Shallow land burial of low-level radioactive wastes. Ensminger, J.T.; Owen, P.T.; Fore, C.S. (comps.). (Oak Ridge National Lab., Tenn. (USA)). Oct 1977. Contract W-7405-ENG-26. 243p. Dep. NTIS, PC A11/MF A01.

This publication is the first in a series of annotated bibliographies jointly compiled by the staffs of the Ecological Sciences Information Center of the Information Center Complex at Oak Ridge National Laboratory and of Dames and Moore, White Plains, New York. The data file was built to provide information support to Department of Energy researchers in the field of waste disposal and management. The scope of the data base emphasizes studies which deal with the "old" Manhattan sites, commercial disposal sites, and the specific parameters which affect the soil and geologic migration of radionuclides. Specialized data fields have been incorporated into the data base to improve the ease and accuracy of locating pertinent references. Specific radionuclides for which data are presented are listed in the "Measured Radionuclides" field, and specific parameters which affect the migration of these radionuclides are presented in the "Measured Parameters" field. In addition, each document referenced in this bibliography has been assigned a "relevance" number to facilitate sorting the documents according to their pertinence to shallow land burial technology. The documents are rated 1, 2, 3, or 4, with 1 indicating direct applicability to shallow land burial technology and 4 indicating that a considerable amount of interpretation is required for the information presented to be applied. The references are arranged by the organization responsible for the research, with lead authors appearing alphabetically within each installation group. Indexes are provided for author, title, geographic location, keywords, subject categories, measured radionuclides, and publication description. 129 abstracted references.

25939 (Y/OWI/SUB—77/42503) Preliminary environmental assessments of disposal of rock mined during excavation of a federal repository for radioactive waste. (NUS Corp., Washington, D.C.

(USA)). Sep 1977. Contract W-7405-ENG-26. 334p. Dep. NTIS, PC A15/MF A01.

Since the environmental impact of mined rock handling will be dependent not only upon the nature of the material and the way in which it might be disposed but also upon the features of the disposal site area and surroundings, it was necessary to select "reference environmental locii" within the regions of geological interest to typify the environmental setting into which the rock would be placed. Reference locii (locations) were developed for consideration of the environmental implications of mined rock from: bedded rock salt from the Salina region, bedded rock salt from the Permian region, dome rock salt from the Gulf Interior region, Pierre shale from the Argillaceous region, granite from the crystalline rock region, volcanic basalt rock from the crystalline ash region, and carbonate rock from the limestone region. Each of these reference locii was examined with respect to those demographic, geographic, physical and ecological attributes which might be impacted by various mined rock disposal alternatives. Alternatives considered included: onsite surface storage, industrial or commercial use, offsite disposal, and environmental blending. Potential impact assessment consists of a qualitative look at the environmental implications of various alternatives for handling the mined rock, given baseline characteristics of an area typified by those represented by the "reference locus".

25940 (Y/OWI/SUB—7009/4) **Fine-grained sheet silicate rocks.** Weaver, C.E. (Union Carbide Corp., Oak Ridge, Tenn. (USA). Office of Waste Isolation). Sep 1977. Contract W-7405-ENG-26. 83p. Dep. NTIS, PC A05/MF A01.

Considerable interest has been shown in the possibility of using shales as repositories for radioactive waste and a variety of other waste products, and it appears that over the next few years much money and effort will be expended to investigate and test a wide variety of shales. If shales are to be studied in detail by a large number of investigators, it is important that all concerned have the same concept of what constitutes a shale. The term shale and other terms for fine-grained rocks have been used for many years and have been continually redefined. Most definitions predate the development of modern instrumentation and are based on field observations and intuition; however, the main problem is the diversity of definitions. An attempt is made here to develop a simple, rational classification of fine-grained sediments, and it is hoped that this classification will eliminate some of the present ambiguity. In order that the classification be pertinent, mineral composition and textural data were compiled and evaluated. The data on unconsolidated and consolidated sediments were contrasted and the effects of burial diagenesis assessed. It was found necessary to introduce a new term, physil, to describe all sheet silicate minerals. In contrast to the term clay mineral, the term physil has no size connotation. A simple classification is proposed that is based on the percentage of physils and grain size. In Part II the fine-grained physil rocks are classified on the basis of physil type, non-physil minerals, and texture. Formations are listed which have the mineral and textural characteristics of the most important rock types volumetrically. Selected rock types, and the formations in which they can be found, are recommended for laboratory study to determine their suitability for the storage of high-level radioactive waste.

25941 **Hazard associated with vitrified high-level radioactive waste.** Hill, M.D. (National Radiological Protection Board, Harwell (UK)). *Radiol. Prot. Bull.;* No. 21, 12-14(Oct 1977).

Evidence is presented to show that estimates of the hazard associated with vitrified high-level radioactive waste can be misleading if they are made by comparing the waste with the uranium ore from which it originated. There is a wide variation in the results of comparisons of the time course of such parameters as total activity, specific activity, activity per unit volume and number of maximum permissible annual intakes. These comparisons are concerned only with inherent radioactivity. Management and disposal practices are likely to be of greater importance in determining any eventual risk to man.

25942 **Leaching behavior of strontium-90 in cement composites.** Matsuzuru, H. (Environmental Safety Research Laboratory, Reactor Safety Centre, Japan); Ito, A. (Atomic Energy Research Institute, Tokai, Japan). *Ann. Nucl. Energy;* **4**: No. 9, 465-470(1977).

The leaching of ^{90}Sr from a cement composite into an aqueous phase has been studied by the method recommended by IAEA. The amount leached was measured as functions of waste to cement ratio (Wa/C), salt content of waste, temperature of leachant and curing time of specimens. The leach coefficient of ^{90}Sr varies from ca. 6×10^{-8} to 4×10^{-7} cm^2/day depending on the composition of specimen and the leaching conditions. The leachability depends on such factors as Wa/C, temperature of leachant and curing time. The Portland cement composite gives a higher leaching fraction than the slag cement one. Additives used have no significant effect on the leachability. The amount leached in deionized water as a leachant is higher than in synthetic sea water. On the basis of the results obtained, the amount of ^{90}Sr leached from a composite of 200 l drum size for an extended period was estimated.

ENVIRONMENTAL ASPECTS

REFER ALSO TO CITATION(S) 25926, 25939, 26874, 26887, 26889, 26998

25943 (PNL—2253) **Ecology of the 200 Area plateau waste management environs: a status report.** Rogers, L.E.; Rickard, W.H. (eds.). (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). Oct 1977. Contract EY-76-C-06-2130. 215p. Dep. NTIS, PC A10/MF A01.

Separate abstracts were prepared for nine sections of this report.

25944 (PNL—2253, pp 1.1-1.18) **Introduction.** Uresk, V.A.; Rogers, L.E. Oct 1977.

In Ecology of the 200 Area plateau waste management environs: a status report.

A general description of ecosystem functioning introduces the need for comprehensive ecological studies as part of the overall waste management operations on the 200 Area plateau. A history of waste management operations and location of 200 Area facilities is provided. An estimate of inventories of radioactive materials in the 200 Area cribs, ponds, and ditches at the end of September 1976 is included.

25945 (PNL—2253, pp 2.1-2.5) **Abiotic components.** Rickard, W.H.; Emery, R.M. Oct 1977.

In Ecology of the 200 Area plateau waste management environs: a status report.

The climatic regime of the 200 Area plateau consists of cold winters, hot summers and low precipitation amounts. Properties of surface soils and physiochemical properties of ponds and ditches are described.

25946 (PNL—2253, pp 3.1-3.40) **Biotic components.** Uresk, D.W.; Fitzner, R.E.; Rogers, L.E.; Rickard, W.H. Oct 1977.

In Ecology of the 200 Area plateau waste management environs: a status report.

Representative plant communities are described. The major community is dominated by sagebrush/cheatgrass-sandberg blue grass. Mammal, bird and insect species inhabiting the 200 Area plateau are representative of surrounding regions. Prairie falcons are the only species present possibly threatened with extinction. They do not nest on the plateau but probably forage over the area.

25947 (PNL—2253, pp 4.1-4.10) **Energy flow and mineral cycling mechanisms.** Rogers, L.E. Oct 1977.

In Ecology of the 200 Area plateau waste management environs: a status report.

Analysis of energy flow patterns and mineral cycling mechanisms provides a first step in identifying major transport pathways away from waste management areas. A preliminary food web pattern is described using results from ongoing and completed food habit studies. Biota possessing the greatest potential for introducing radionuclides into food chains leading to man include deer, rabbits, hares, waterfowl, honeybees and upland game birds and are discussed separately.

25948 (PNL—2253, pp 5.1-5.14) **Radionuclide transport.** Cataldo, D.A.; Paine, D.; Cushing, C.E.; Emery, R.M.; Vaughan, B.E. Oct 1977.

In Ecology of the 200 Area plateau waste management environs: a status report.

The availability of radionuclides to biota is discussed especially with reference to specific elements in local soils. Two annual plant species have received concentrated study. These are cheatgrass and tumbleweed, both important inhabitants of waste burial sites. Little is known concerning the radionuclide dynamics of perennial grasses, forbs, or shrub species. The potential for radionuclide transport by jackrabbits, waterfowl, small mammals, and biota inhabiting pond systems is discussed. Concentration ratios are tabulated.

25949 (PNL—2253, pp 6.1-6.13) **Impact of radioactive waste management operations.** Paine, D.; Rogers, L.E.; Uresk, D.W. Oct 1977.

In Ecology of the 200 Area plateau waste management environs: a status report.

Impact assessment of radioactive waste management operations is considered separately for nonradiological impact on biota, impact on ecosystem structure and function and radiological impact on biota. Localized effects related to facility construction and maintenance activities probably occur but the large expanse of relatively undisturbed surrounding landscape minimizes any overall effects.

25950 (PNL—2253, pp 7.1-7.15) **Management models.** Sauer, R.; Schreckhise, R.G.; Uresk, D.W. Oct 1977.

In Ecology of the 200 Area plateau waste management environs: a status report.

Management models are used here as a vehicle to organize the ecological research tasks required for the biotic transport program. Three kinds of models are described: ecosystem level simulation models; radionuclide transport models; and optimization models. The ecosystem simulation model is included here as a coupling agent between climatic variables and waste management practices with the transport and optimization models. Certainly the potential for radionuclide transport depends to a large degree upon the density, type and vigor of plant species inhabiting burial sites. These parameters, in turn, are related to past management practices, precipitation patterns, and successional stages, all predictable using current techniques.

25951 (PNL—2253, pp 8.1-8.22) **Applications to waste management operations.** Paine, D.; Uresk, V.; Schreckhise, R.G. Oct 1977.

In Ecology of the 200 Area plateau waste management environs: a status report.

Ecological studies of the 200 Area plateau waste management environs have provided preliminary answers to questions concerning the environmental health of associated biota, potential for radionuclide transport through the biotic system and risk to man. More importantly creation of this ecological data base provides visible evidence of environmental expertise so essential for maintenance of continued public confidence in waste management operations.

25952 (PNL—2253, pp 9.1-9.17) **Future research needs.** Rogers, L.E.; Cataldo, D.A. Oct 1977.

In Ecology of the 200 Area plateau waste management environs: a status report.

The future research needs of the biotic transport program are identified in terms of six research categories. Each category is identified with a starting date, period of emphasis and completion date. Research tasks are identified for each category and scheduled in a milestone chart. Task interrelationships are identifid in a flow diagram to facilitate program management.

HEALTH AND SAFETY

REFER ALSO TO CITATION(S) 26933

REGULATIONS

ACCOUNTABILITY AND SAFEGUARDS

REFER ALSO TO CITATION(S) 26332

25953 (RFP—2634) **Joint ANSI-INMM 8.1: Nuclear Regulatory Commission study of uranium hexafluoride cylinder material accountability bulk measurements.** Pontius, P.E.; Doher, L.W. (National Bureau of Standards, Washington, D.C. (USA); Atomics International Div., Golden, Colo. (USA). Rocky Flats Plant). 1977. Contract EY-76-C-04-3533. 8p. Dep. NTIS, PC A02/MF A01.

This paper reports the progress to date in a demonstration of the procedures in ANSI N15.18-1975, "Mass Calibration Techniques for Nuclear Material Control," sponsored and funded by the Nuclear Regulatory Commission (NRC). The philosophy of mass measurement as a production process, as promulgated in ANSI N15.18-1975, is reviewed. Special emphasis is placed on the use of artifact Reference Mass Standards (RMS) as references for uranium hexafluoride (UF_6) calibration and bulk measurement processes. The history of the creation of the artifact concept and its adoption by ANSI N15.18-1975 and the Nuclear Regulatory Commission is narrated. The program now under way is specifically described; including descriptions of the RMS, their calibration, and the assignment of uncertainties to them by the National Bureau of Standards (NBS). Instrument tests, in-house standards (IHS), and assignment of values relative to the RMS-NBS values at nuclear facilities which measure UF_6 cylinders are described. Comparisons and the data base are detailed to provide realistic measurement process parameters associated with accountable transfer of UF_6. The as yet uncompleted part of the demonstration is described, that is, to further close the measurement loop by verification both between and within facilities.

25954 (SAND—77-1367) **Users guide for evaluating alternative fixed-site physical protection systems using "FESEM".** Chapman, L.D.; Kinemond, G.A.; Sasser, D.W. (Sandia Labs., Albuquerque, N.Mex. (USA)). Nov 1977. Contract EY-76-C-04-0789. 246p. Dep. NTIS, PC A11/MF A01.

The objective of this manual is to provide a guide for evaluating physical protection systems using the Forcible Entry Safeguards Effectiveness Model (FESEM). It is intended for use by personnel involved in evaluating fixed-site security systems, or managers involved in making decisions related to the modification of existing protection systems or the implementation of new systems. This users' guide has been written for an audience which has some previous computer experience. (LK)

25955 **Regional nuclear fuel cycle centres. IAEA study project.** Meckoni, V.; Catlin, R.J.; Bennett, L.L. (International Atomic Energy Agency, Vienna (Austria)). *Energy Policy;* **5**: No. 4, 267-281(Dec 1977).

The results of a study project on regional nuclear fuel cycle centres, initiated by the International Atomic Energy Agency in 1975 to examine the economic, safety, safeguards and security aspects of a multinational approach to the planning and establishment of nuclear fuel cycle facilities are reported. The study concentrated on the transport, storage, processing and recycling activities involved in the fuel cycle. The results would help any group of interested member states to develop alternative strategies for their present and projected nuclear fuel cycle needs, as well as evolve institutional, legal and other appropriate arrangements for establishing fuel cycle centres on a multinational cooperative basis.

SOURCES

REFER ALSO TO CITATION(S) 27020

ISOTOPE AND RADIATION SOURCE TECHNOLOGY

DESIGN AND FABRICATION

REFER ALSO TO CITATION(S) 26740, 26741

ISOTOPIC POWER SUPPLIES

DESIGN AND FABRICATION

25956 (GESP—7134) **Multi-hundred watt radioisotope thermoelectric generator program. Annual report, 1976—1977. Final report.** (General Electric Co., Philadelphia, Pa. (USA). Space Div.). 1978. Contract EX-76-C-16-3066. 465p. (GEMS—430). Dep. NTIS, PC A20/MF A01.

During the reporting period, 1976 to 1977, development, fabrication and testing of the MHW-MJS RTGs were completed. The seven flight qualified units, six for flight and one spare, were delivered to KSC during May and June 1977. The two Voyager launches are scheduled for Aug. 20 and Sept. 1, 1977. The significant events and activities occurring on the MHW-MJS Program are summarized. (TFD)

HYDROGEN

PRODUCTION

REFER ALSO TO CITATION(S) 25631

25957 (PB—274058) **Studies of hydrogen liquefier efficiency and the recovery of the liquefaction energy.** Voth, R.O.; Parrish, W.R. (National Bureau of Standards, Boulder, Colo. (USA)). Aug 1977. 63p. (NBSIR—77-862). NTIS PC A04/MF A01.

Liquid hydrogen is a potential synthetic fuel. It is nonfossil, its production and storage technology is well developed, and it is inherently nonpolluting. However, the economics of liquefying hydrogen are costly both in the energy required to produce the liquid and in the capital costs of the liquefier. These costs could be reduced by increasing the liquefier efficiency and/or by recovering a portion of the liquefaction energy at the use site. This paper provides the maximum hydrogen liquefier efficiency based on the efficiency of available components and the fraction of original liquefaction energy that can be recovered at the use site. Since the inefficient compressors and expanders are the major cause of liquefier inefficiency, no increase in liquefier efficiency above the current 30 to 35 percent is probable without a corresponding increase in compressor and expander efficiency -- a difficult task since both the compressors and expanders have a long and stable history of development. However, roughly one-third to one-half of the actual energy required to liquefy hydrogen can be recovered at the use site and this represents a cost credit for liquid hydrogen.

25958 **Powdered metal source for production of heat and hydrogen gas.** Black, S.A.; Jenkins, J.F. US Patent 4,017,414. 12 Apr 1977. Filed date 8 Dec 1975. 8p.

The patent relates to micro electrochemical cells which utilize an intimate mixture of active and passive metals, which are reacted with seawater for producing heat and hydrogen gas for use as a heat source, energy source, or buoyancy generator for use in remote areas.

THERMOCHEMICAL PROCESSES

REFER ALSO TO CITATION(S) 25986

25959 (LA-UR—77-2985) **Status of European thermochemical hydrogen programs.** Bowman, M.G. (Los Alamos Scientific Lab., N.Mex. (USA)). 1977. Contract W-7405-ENG-36. 5p. (CONF-771131—3). Dep. NTIS, PC A02/MF A01.

From DOE annual chemical energy storage and hydrogen energy system contracts review; Baltimore, MD, USA (16 Nov 1977).

An invited paper on Thermochemical Hydrogen Production was presented at an International Symposium on Energy Sources and Development held in Barcelona, Spain, October 19-21, 1977. Visits were then made to the following European Laboratories engaged in thermochemical hydrogen research: (1) The Euratom Central Research Center, Ispra, Italy. (2) The Center for Nuclear Research at Saclay, France. (3) The Rheinisch-Westfalische Hochschule in Aachen, Germany. (4) The Julich Nuclear Research Center at Julich, Germany. The visits to the listed laboratories were primarily to learn the scope of the different programs and the general areas of information expected to be made available under the recently signed International Energy Agency Implementing Agreement on the Production of Hydrogen from Water. From observations made during these Visits, the following conclusions were reached: (1) It is clear that the Europeans are directing their efforts towards relatively short term development of better methods for the production and utilization of hydrogen. (2) The European effort on thermochemical hydrogen research and development is significantly greater than the total of U.S. programs. (3) It will be advantageous for the United States to cooperate in information exchange activities under the I.E.A. The description of the different visits is given in the format of a trip report.

25960 (NP—22964) **Assessment of thermochemical hydrogen production.** Dafler, J.R.; Foh, S.E.; Schreiber, J.D. (Institute of Gas Technology, Chicago, Ill. (USA)). 1977. 7p. of Gas Technology, Chicago, IL.

A base-case, or first-cut, flowsheet for IGT Cycle B-1 has been completed. Calculation of the energy balance has allowed us to define the worst problem areas in the overall process, and optimization effort has been directed to these parts of the process. Operation of the $FeCl_2$-hydrolysis at pressures sufficient to interface with projected hydrogen transmission lines will apparently necessitate higher hydrolysis temperatures. Higher pressure, however, favors some of the critical separation steps.

STEAM-IRON PROCESS

25961 (FE—2435-16) **Development of the steam—iron process for hydrogen production. Project 9010 quarterly report No. 4, April 1—June 30, 1977.** (Institute of Gas Technology, Chicago, Ill. (USA)). Nov 1977. Contract EX-76-C-01-2435. 47p. Dep. NTIS, PC A03/MF A01.

Based on the work conducted during the present quarter, the following conclusions are drawn: Continuous ore circulation can be achieved in the steam-iron reactor. The high-pressure char feeding system incorporating the slurry vaporizer operates very well. IGT Iron-Magnesia 8, containing 60 wt % iron, 10 wt % magnesia, and 4 wt % silica, has 30% higher attrition resistance and similar reactivity to siderite. Fluidization velocities above 0.16 and 0.63 ft/s are needed to prevent sintering with Montana subbituminous coal char at 1750 and 2025°F, respectively. A fluidization velocity above 0.44 ft/s is required to prevent sintering with Western Kentucky bituminous coal char at 1890°F. Preliminary analysis shows that for Husky char the rate of fines generation due to attrition at the gas distributor is approximately proportional to the 1.2 power of the orifice-gas jet velocity. Attrition rate of siderite at the gas distributor increases in proportion to about the 0.76 power of the gas density. Increasing gas velocity at the cyclone inlet, from 25 to 95 ft/s, increases char attrition from 0.6 to 2.3 weight percent. Attrition of siderite ore in the cyclone reduces at higher pressure. Increasing solids circulation rates increases solids inventory in the transition zone between the dense- and the lean-phase lift, more than that calculated by literature correlations.

STORAGE

25962 (SAND—77-8296) **Hydrogen compatibility of structural materials for energy storage and transmission applications. Semiannual report, April 1, 1977—October 1, 1977.** Robinson, S.L. (Sandia Labs., Livermore, Calif. (USA)). Jan 1978. Contract EY-76-C-04-0789. 49p. Dep. NTIS, PC A03/MF A01.

A series of 80 self-loaded tensile specimens have been subjected to 821 cycles of hydride charging and discharging, while in intimate contact with the hydride powder and environment. No failures due to the environment occurred. Post exposure measurement of mechanical properties disclosed no degradation of mechanical properties, and no significant alteration of the fracture surface appearance in mild steel, aluminum and stainless alloys. These observations are explained in terms of delayed failure phenomena, and the conclusion reached that prototype vessel operation should be safe for significant numbers of cycles of operation. The experimental hydrogen pipeline began operation in September at 7 MPa pressure of hydrogen. Operating conditions are described. The initial defects and test matrices are discussed. Development of more hydrogen compatible mild steel alloys and microstructures is discussed and preliminary results on titanium modifications to A516 steel are presented. Protective coating work that has been completed is summarized: these efforts have been discontinued pending further evidence of the technical and economic viability of coatings in hydrogen energy systems.

TRANSPORT

REFER ALSO TO CITATION(S) 25962

25963 (CONF-771039—10) **Prospects for the use of hydrogen as an energy carrier.** Gregory, D.P. (Institute of Gas Technology, Chicago, Ill. (USA)). 1977. 16p. of Gas Technology, Chicago.

From 13. rare earth research conference; Olgebay Park, WV, USA (16 Oct 1977).

As the United States, and the rest of the world, begin to deplete their resources of fossil fuels, attention must be paid to the best way to use the more abundant energy resources such as nuclear and solar energy. At the present time, technology is directed to converting these energy sources primarily to electricity. Electricity presently supplies only about 10 percent of our energy needs, is relatively inflexible in use because it cannot be stored, and is expensive to transmit underground. It is hard to see how electric power can find universal use for such things as air transportation, automobiles, and many other applications.

INDUSTRIAL AND COMMERCIAL USE

REFER ALSO TO CITATION(S) 25664

OTHER SYNTHETIC AND NATURAL FUELS

PREPARATION

PREPARATION FROM WASTES OR BIOMASS

REFER ALSO TO CITATION(S) 25973, 26004, 26005, 26006, 26007, 26008, 26009, 26010, 26011, 26012, 26013, 26014, 26015, 26016, 26017, 26018, 26019, 26020, 26026

25964 (PB—271142) **Technology for the conversion of solar energy to fuel gas. Annual report.** (SEE ALSO- 9500396 National Center for Energy Management and Power, Philadelphia, Pa. (USA)). 31 Jan 1973. 76p. (NSF/RANN/SE/GI—27976/72/4).

The principal objective of this research project is the generation of methane gas by the anaerobic digestion of organic matter. Progress toward achievement of this goal has been concentrated along two lines. The first task is experimental and is based on the use of laboratory-scale digesters to optimize methane gas production. These digesters have been designed and constructed to provide automatic operation and data collection, and flexibility for future research efforts. The feasibility of two-stage digestion is being investigated as a means of overcoming the problems of process stability that have plagued sewage sludge digesters. This investigation involves the isolation, quantification, and characterization of the bacterial flora utilizing techniques developed for the investigation of rumen flora. The second task is that of investigating source feed

materials for full-scale methane generation. Preliminary investigations have been made into the availability of feed material both from organic wastes and from energy crops.

ALCOHOL FUELS

REFER ALSO TO CITATION(S) 26591

PREPARATION

CHEMICAL SYNTHESIS

25965 Selection of the optimum height-diameter ratio to be used in low-pressure methanol synthesis. Nitikin, A.K.; Savushkina, V.A. *Sov. Chem. Ind. (Engl. Transl.);* **9**: No. 2, 136-137(Feb 1977).

Translated from Khim. Prom-st. (Moscow); 9: No. 2, 132-136(Feb 1977).

The article examines what effects on a set of factors are produced by varying the height to diameter ratio (H/sub c//D/sub int/) in a reactor used for the low-pressure (~ 50 kg/cm²) synthesis of methanol on a copper-containing catalyst. A function of the adjusted expenses, which includes the operating expenses and the capital expenses, was proposed as the target function. Calculation relationships are introduced which connect the target functions with the H/sub c//D/sub int/ ratio. Mathematical methods are used to find the minimum of the function, which corresponds to the optimum H/sub c//D/sub int/ ratio.

25966 Partial oxidation of fuel oil route to methanol production. Greenwood, C.W. (Davy Powergas Ltd, London, Engl). pp 39-46 of Advanced in Petrochemical Technology conference. Rugby, England; Inst. of Chemical Engineers (1977).

From Advanced in Petrochemical Technology confernece; London, England (11 May 1977).

The increasing shortage and escalating price of natural gas and naphtha has led to great renewal of interest in the partial oxidation of fuel oil for the production of synthesis gases and hydrogen. Modern methanol plants utilize copper based catalysts which are sulphur sensitive and require high purity feed. A description is given of the process route selected and indicates areas for future energy savings.

25967 Mechanism of methanol synthesis from carbon dioxide and hydrogen. III. Determination of rates of individual stages using ^{14}CO. Rozovskii, A.Ya.; Lin, G.I.; Liberov, L.G.; Slivinskii, E.V.; Loktev, S.M.; Kagan, Yu.B.; Bashkirov, A.N. (Inst. of Petrochemical Synthesis, Moscow). *Kinet. Catal. (USSR) (Engl. Transl.);* **18**: No. 3, 578-585(1977).

Translated from Kinet. Katal.; 18: No. 3, 691-699(1977).

Transition kinetics of labeled atoms has been considered in a system that includes a sequential reaction with reversible steps. Methods are proposed for estimating the rates of individual steps on the basis of one specific radioactivity measurement on components of the reaction mixture. The methods proposed are used in estimating the rates and observed activation energies of mutual conversions of carbon monoxide and carbon dioxide under conditions of methanol synthesis from carbon dioxide and hydrogen. The values found agree with the results of the kinetic study.

PREPARATION FROM WASTES OR BIOMASS

REFER ALSO TO CITATION(S) 26021

PROPERTIES

25968 (AD-A—043330) **Evidence for the structures of adsorbed NH_3 and H_2O on RU(001).** Madey, T.E.; Yates, J.T. Jr. (National Bureau of Standards, Washington, D.C. (USA)). 15 Jul 1977. Contract N00014-77-F-0012. 6p. NTIS PC A02/MF A01.

The adsorption of NH_3 and H_2O on Ru(001) have been studied using the Electron Stimulated Desorption Ion Angular Distribution (ESDIAD) method, in conjunction with thermal desorption spectroscopy and LEED. The results suggest that chemisorbed NH_3 and H_2O are bonded to Ru via the N and O atoms, respectively, with H atoms pointed away from the surface. The utility of ESDIAD for determination of structures of adsorbed molecules is indicated.

25969 Absorption of ammonia with organic solvents. Dudakov, L.P.; Leites, I.L. *Sov. Chem. Ind. (Engl. Transl.);* **9**: No. 1, 33-34(Jan 1977).

Translated from Khim. Prom-st. (Moscow); 9: No. 1, 32-34(Jan 1977).

The solubility of ammonia in ethylene glycol, benzyl alcohol, tetrahydrofurfuryl alcohol, cyclohexanol and some other organic solvents is investigated. The investigations were conducted under static conditions in the temperature interval from 17 to 140°C with ammonia pressures to 12 kg/cm². The unit for measuring ammonia solubility under pressure is described and a diagram of it is shown. The heats of solution of ammonia in these solvents is calculated from the experimental data.

PREPARATION

25970 Conditions for regenerating an iron—molybdenum—tungsten catalyst used in ammonia synthesis. Swmylina, I.A.; Karibdzhanyan, N.A.; Lachinov, S.S.; Anfimov, V.A.; Shumlyakovskii, Ts.I. *Sov. Chem. Ind. (Engl. Transl.);* **9**: No. 2, 126-127(Feb 1977).

Translated from Khim. Prom-st. (Moscow); 9: No. 2, 119-121(Feb 1977).

The process of regenerating the Fe-Mo-W catalyst MV-5 for ammonia synthesis in an out-of-column regeneration reactor is investigated. The results were compared with similar data for the SA-1 catalyst. It is shown that the regeneration of the MV-5 catalyst proceeds much more vigorously and is complete in a shorter time and at lower temperatures. Samples of the MV-5 catalyst taken from different layers of the reactor are more active than the SA-1 catalyst regenerated under the same conditions.

25971 Economic efficiency of optimizing existing units for carbon monoxide conversion. Krainov, V.N.; Oradzhanov, G.A.; Kucherov, M.N.; Sashina, E.K. *Sov. Chem. Ind. (Engl. Transl.);* **9**: No. 2, 163-165(Feb 1977).

Translated from Khim. Prom-st. (Moscow); 9: No. 2, 152-154(Feb 1977).

Some problems of the economic and technological investigation of existing units for carbon monoxide conversion in large-scale production of synthetic ammonia are examined. The study of a rather complete mathematical model of the process and the data of a passive experiment revealed the possibility of carrying out the optimum control of the process and determined the significance of this stage on production costs. A target control function is selected (the minimum net cost per unit of production) and a procedure for its computation is proposed. The correlation of the target function with the most important process parameters is found, potential sources for raising production efficiency are determined and the per-unit savings which may be expected in a changeover from the starting mode to the optimum one are calculated.

25972 Calculation and optimization of existing energy-technological systems for ammonia production. Egerev, V.V.; Raskin, A.Ya.; Sosna, M.Kh.; Sokolineskii, Yu.A.; Garkabii, A.P.; Berlizov, N.D.; Yagnyatinskii, B.V.; Semenov, V.P.; Mukosei, V.I.; Bondar, I.E. *Sov. Chem. Ind. (Engl. Transl.);* **9**: No. 1, 52-56(Jan 1977).

Translated from Khim. Prom-st. (Moscow); 9: No. 1, 50-53(Jan 1977).

The energy-technological system for preparing the synthesis gas in the production of ammonia is examined. Calculation of the system was conducted on the basis of mathematical models of the reactors and the heat exchange equipment. The net cost of 1 t of NH_3 was selected as the optimization criterion. The nature of the influence of various parameters on the technological and economic operating features was investigated, and an optimal version was found, which after pilot plant checks was accepted for use. The adoption of the calculated operating mode allows the ammonia output to be increased by 0.38 t/hr and its net cost to be reduced by 0.3 rubles per tonne of NH_3. 3 figures, 12 references.

SOLID WASTE FUELS

REFER ALSO TO CITATION(S) 26027, 26531, 26532, 26575

25973 (AD-A—042578) **Technology evaluation of Army-scale waste-to-energy systems.** Hathaway, S.A.; Dealy, R.J. (Army Construction Engineering Research Lab., Champaign, Ill. (USA)). Jul 1977. 85p. (CERL-IR-E—110). NTIS PC A05/MF A01.

This investigation evaluated current and emerging technologies for converting waste to energy in applications scaled for use on Army fixed facilities and installations. Technologies reviewed include: mass burning of wastes in package (modular) and field-erected systems; use of refuse-derived fuel (RDF) in new combustion capital and as a supplementary fuel in existing Army-scale central steam generators; pyrolytic conversion of waste to a gaseous and liquid fuel; and anaerobic digestion of wastes to a fuel gas. The report includes application of a rating system for candidate technologies which considers dependability, practicability, conservation, environmental compatibility, economics, and length of operational history. Use of package waste-to-energy systems and use of RDF as a

supplementary boiler fuel are treated in detail. Fully satisfactory methods of surveying installation solid waste to determine energy-recovery system design points are lacking, and currently used methods can result in misapplication of capital. Combustion of unprocessed and minimally processed (Once-shredded) solid waste in field-erected integrated waterwall combustors equipped with mechanical stokers is currently the superior energy recovery technology. Anaerobic digestion and pyrolytic conversion were found to be unproven but developing.

25974 Processed refuse: a salvage fuel for existing boilers. Hollander, H.I. (Gilbert Assoc, Inc, Reading, Pa). pp 317-333 of Proceedings on the Ontario industry waste conference. Toronto; Ontario Ministry of the Environment (1977).

From 24. proceeding of the Ontario industry waste conference460Toronto, Ontario; Toronto, Ontario (30 Jun 1977).

This emerging, locally derived fuel source is becoming available in several prepared forms which could be suitable for many existing steam generators with only modest modification required. The thermochemical characteristics are compared with those of typical coals and several production wastes which have been used as salvage fuels. Some of the pertinent application parameters are discussed and associated operation, performance and management considerations. This application review is essentially confined to existing boiler installations and only the use of "prepared" solid fuels derived from refuse.

HYDRO ENERGY

25975 (NP—23020) **Investigation of failure of Walter :Bouldin Dam FPC project No. 2146 and safety of other dams of the Alabama Company FPC project Nos. 82, 349, 618, 2146, 2165, 2203, 2407, 2408, 2628.** (Federal Power Commission, Washington, D.C. (USA). Bureau of Power). Feb 1976. 152p. TIC.

Results of the investigation of the failure of the Walter Bouldin Dam made by the Staff of the Bureau of Power, Federal Power Commission are presented. Results of an examination of the potential for failure of the other dams of the Alabama Power Company conducted by the Federal Power Commission are also included.

RESOURCES AND AVAILABILITY

25976 (NP—22951) **Water resources appraisal for hydroelectric licensing. Evaluation report, project No. 287.** (Federal Power Commission, Washington, D.C. (USA). Bureau of Power). 1976. 52p. TIC.

Plans to modify the 50-yr-old Dayton Hydroelectric Power Plant on the Fox River in Illinois were evaluated in terms of technical feasibility, environmental effects, and financial soundness. These studies indicated that modification of the Dayton Plant to increase power production would not be warranted. (LCL)

25977 (NP—22953) **Upper Mississippi River Basin above Minnesota River, Minnesota. Appraisal report, water resources appraisal for hydroelectric licensing.** (Federal Power Commission, Washington, D.C. (USA). Bureau of Power). 1975. 88p. TIC.

The Upper Mississippi River Basin above the Minnesota River lies in central Minnesota and has a drainage area of about 19,700 square miles. Water resources development in the study area includes six Federal reservoirs in the upper reaches which are operated primarily to reduce flood stages on the Mississippi River. The reservoirs also aid and maintain fish and wildlife, provide water supply for downstream communities, and regulate flows for hydroelectric power and pollution abatement. Also included are 14 hydroelectric developments with a total installed capacity of 63,104 kW. All of the hydro power developments are operated on a run-of-river basis except the Bemidji development which has a reservoir with 40,500 acre-feet usable for streamflow regulation. Eight of the hydroelectric power installations have been licensed by the Federal Power Commission and applications for licenses are pending for two projects. The basin's power requirements are met primarily by two utilities: the Northern States Power Company provides 86 percent of the basin capacity, and the Minnesota Power and Light Company provides 10 percent. Total generating capacity within the basin is about 5,321 MW, almost all of which is in steam-electric plants. Two hydroelectric developments, the Blanchard and Twin City developments, Project No. 346 and Project No. 362, respectively, are discussed in detail in this report because their Federal Power Commission licenses have expired and they are under consideration for relicensing or recommendation for take-over by the United States. The projects are now operating under annual licenses.

25978 (TID—28173) **Water resources appraisal for hydroelectric licensing, Kern River Basin, California.** (Federal Power Commission, Washington, D.C. (USA). Bureau of Power). 1977. 93p. Dep. NTIS, PC A05/MF A01.

A plan for comprehensive development of water and related land resources of the Kern River (California) was evaluated in terms of available water resources, power demand, environmental effects and technical and economic feasibility. It was concluded that enlargement of the Isabella Reservoir would be beneficial and economically feasible and that the downstream power plants could operate efficiently for years, could increase the amount of hydroelectric power generated, and should be licensed. (LCL)

PLANT DESIGN AND OPERATION

REFER ALSO TO CITATION(S) 26481

25979 (AD-A—043876) **Powerhouse intake gate catapult study, Big Bend Dam, South Dakota, and Stockton, Harry S. Truman, and Clarence Cannon Dams, Missouri. Hydraulic model investigation. Final report, December 1973—January 1976.** George, J.F.; Pickering, G.A. (Army Engineer Waterways Experiment Station, Vicksburg, Miss. (USA)). Apr 1977. 76p. (WES-TR-H—77-8). NTIS PC A05/MF A01.

Tests were conducted to determine the range of gate openings and hydraulic conditions at which the service gates at Big Bend, Stockton, and Clarence Cannon powerhouses can be used for watering-up the scroll case area. The test data should also be applicable to Harry S. Truman powerhouse. Measurements of gate catapult heights, uplift forces, discharge coefficients, and pressures throughout the system were made for various gate openings and pool elevations. Although the model gate was suspended from a wire cable, cable stretch and tension were not simulated. Also, roller bearing and seal friction were somewhat greater in the model than in the prototype. The discharge coefficients that were measured for flow underneath the gate were about as expected. However, the discharge coefficients for the back-of-gate orifices were considerably higher than had been expected. The pressures measured at various locations in the penstock, on the gate, and in the scroll case area were not indicative of a blow due to water hammer, although there was a pronounced change in pressures at the time when the scroll case became full and flow started up the gate slot. The pressures measured underneath the gate on the bottom structural member could not be directly related to the uplift force. Although the data could not be generalized for specific design criteria, conclusions are given which can be used as guidance for design of intake gates.

25980 All-union red labor banner order-bearing trust, "spetsgidroenergomontazh". Lokhmatikov, G.P.; Rudnik, A.G. ("Spetsgidroenergomontazh", USSR). *Energomashinostroenie;* No. 7, 44-46(1977). (In Russian).

The history of the "Spetsgidroenergomontazh" Trust (Specialized Trust for Hydroelectric Power Plant Assembly) is surveyed and some problems of the technology of assembling hydroelectric power units and mechanization of the assembly work are discussed. The personnel of the Trust now numbers about 5000 people. In 1976, it handed over 18 hydraulic power units for operation.

POWER CONVERSION SYSTEMS

25981 Dynamic stability of hydraulic generators operating under the conditions of consumption of reactive capacity. Ragozin, A.A. ("Gidroproekt"–im. S.Ya. Zhuka, Leningrad, USSR). *Izv. Vyssh. Uchebn. Zaved., Energ.;* No. 7, 125-128(Jul 1977). (In Russian).

Results of calculations of the dynamic stability of generators under the conditions of underexcitation are presented. Limits of dynamic stability are investigated for various variants of weighting of the power transmission operation conditions.

SOLAR ENERGY

25982 (RLO/2230/T5—1) **Community leaders workshop on solar energy assessment. Final report.** Venolia, C. (ed.). (Oregon Univ., Eugene (USA). Solar Energy Center). 20 Aug 1977. Contract EY-76-S-06-2230-005. 45p. Dep. NTIS, PC A03/MF A01.

A summary of activities and discussions and general format of a solar energy conference at Eugene, Oregon, sponsored by ERDA to involve local groups in the assessment of environmental and social issues relating to solar energy development are presented. The topics of the three workshops were (1) solar heating and cooling, (2) fuels from biomass, and (3) agricultural and industrial heat. (WHK)

25983 **Optics in solar energy utilization II .** Selvage, C. (ed.). Palos Verdes Estates, CA; Society of Photo-Optical Instrumentation Engineers (1977). 180p. (CONF-760832—P1). .

From 20. annual SPIE technical symposium; San Diego, CA, USA (24 Aug 1976).

Separate abstracts were prepared for 17 of the 20 papers presented. Three of the papers appeared previously as CONF-760832--5, CONF-760832--12, and CONF-760832--23. (WHK)

RESOURCES AND AVAILABILITY

25984 **Precision insolation measurement under field conditions.** Reid, M.S.; Berdahl, C.M.; Gardner, R.A. (California Inst. of Tech., Pasadena). pp 90-92 of Optics in solar energy utilization II . Selvage, C. (ed.). Palos Verdes Estates, CA; Society of Photo-Optical Instrumentation Engineers (1977).

From 20. annual SPIE technical symposium; San Diego, CA, USA (24 Aug 1976).

See CONF-760832—P1.

The Mark 3 Kendall Radiometer, a precision insolation instrument developed for field survey work and for use as a calibration transfer standard, is described. The Mark 3 radiometer is identical, except in two respects, to the Primary Absolute Cavity Radiometer (PACRAD) which has a windowless black cavity receptor mounted in a massive heat sink with a thermopile readout of temperature differences. In the Mark 3 system a flat quartz window seals the cavity aperture and the view angle has been opened to 15°. Calibration and performance of the Mark 3 radiometer are discussed. (WHK)

ECONOMICS

REFER ALSO TO CITATION(S) 26031, 26042, 26047, 26051

25985 (LA—7064-MS) **Prospects for solar energy: the impact of the National Energy Plan.** Roach, F.; Noll, S.; Ben-David, S.; Bickle, L.; Schulze, W. (Los Alamos Scientific Lab., N.Mex. (USA)). Dec 1977. Contract W-7405-ENG-36. 53p. Dep. NTIS, PC A04/MF A01.

The National Energy Plan (NEP) sets as a goal the use of solar energy in two and a half million homes in 1985. A key provision of the NEP (as well as congressional alternatives) provides for the subsidization of solar equipment. The extent to which these subsidies (income tax credits) might offset the impact of continued energy price control is examined. Regional prices and availability of conventional energy sources (oil, gas, and electricity) were compiled to obtain a current and consistent set of energy prices by state and energy type. These prices are converted into equivalent terms ($/10^6 Btu) which account for combustion and heat generation efficiencies. Projections of conventional fuel price increases (or decreases) are made under both the NEP scenario and a projected scenario where all wellhead price controls are removed on natural gas and crude oil production. The economic feasibility (life cycle cost basis) of solar energy for residential space heating and domestic hot water is examined on a state-by-state basis. Solar system costs are developed for each state by fraction of Btu heating load provided. The total number of homes, projected energy savings, and sensitivity to heating loads, alternative energy costs and prices are included in the analysis.

ENVIRONMENTAL, LEGAL, AND INSTITUTIONAL ASPECTS

REFER ALSO TO CITATION(S) 25982, 26031

SOLAR ENERGY CONVERSION

25986 (AD-A—042584) **Efficiencies of various methods for solar energy conversion.** Soper, W.G. (Office of Naval Research (USA). London Branch Office). 20 Jun 1977. 34p. (ONRL-R—6-77). NTIS PC A03/MF A01.

Three methods are examined for converting solar energy to electricity or shaft work: heat engines, thermal decomposition of water to produce hydrogen, and solar cells. Maximum efficiencies of conversion are found to lie between 20% and 50%. For most applications, the heat engine is superior to the water splitting process.

PHOTOVOLTAIC CONVERSION

REFER ALSO TO CITATION(S) 25983, 25986, 26046

25987 (AD-A—043382) **High efficiency solar panel (HESP). Final report, 1 June 1975—15 June 1977.** Scott-Monck, J.; Gay, C.; Stella, P.; Uno, F. (Spectrolab, Inc., Sylmar, Calif. (USA)). 1 Jul 1977. Contract F33615-75-C-2028. 137p. NTIS PC A07/MF A01.

A Family of high efficiency, weldable silicon solar cells, incorporating every feature of advanced technology developed in the past four years, was produced and subjected to space qualification testing. This matrix contained both field and non-field cells ranging in thickness from 0.10 mm to 0.30 mm, and in base resistivity from nominal two to one hundred ohm-cm. Initial power outputs as high as 20 mW/sq.cm (14.8% AMO efficiency) were produced by certain cell types within this group. All these cells had certain common features; a selectively etched front surface which reduced reflection losses, tantalum-palladium-silver front contacts, chromium-palladium-silver back contacts, junction depths approx 0.10 micrometers, and a tantalum pentoxide antireflection coating. For the field cells, acceptor doping was accomplished using a screen printed aluminum paste source. The baseline cell, which was 0.23 mm thick, nominal two ohm-cm, non-field type was produced in three sizes, 2 x 2 cm, 2 x 4 cm and 2 x 6 cm, the others in 2 x 2 cm form. The 2 x 2 cm baseline cell underwent a complete space qualification test cycle including all the typical environmental requirements such as temperature-humidity and thermal cycling. The baseline cell and eleven other types were tested to electron fluence levels of 1 x 10 to the 16th power equivalent 1 MeV electrons/sq.cm, fission spectrum neutron fluence levels of 1 x 10 to the 13th power equivalent 1 MeV neutrons/sq.cm, and were characterized with respect to their radiometric properties.

25988 (DOE/JPL/954877—1) **Study program to develop and evaluate die and container materials. First quarterly report, October 1977—December 1977.** Stiglich, J.J. Jr. (Eagle-Picher Industries, Inc., Miami, Okla. (USA). Miami Research Labs.). 13 Jan 1978. Contract NAS-7-100-954877. 8p. Dep. NTIS, PC A02/MF A01.

The goals of the program are to develop successful die and container materials for handling liquid silicon while it is being formed into photovoltaic cell material. Die and container material development efforts under the current program are shared among three organizations: (1) Miami Research Laboratories (MRL)—Ceramic process development and overall program management; (2) University of Missouri-Rolla (UMR) (Prof. P. D. Ownby)—silicon sessile drop studies with characterization of reaction products and emphasis on atmospheric effects, and (3) Chemetal Corp., Pacoima, Calif. (R. Holzl, president)—special coatings to be applied to test coupons, die shapes and containers provided by MRL and tested/characterized by UMR. The past quarter has been utilized in organizing and beginning experimental efforts. Major subcontracts have been concluded between MRL and the other two facilities. UMR has experimental set-ups approximately 70% complete. MRL has begun fabrication of SiC and Si_3N_4 substrates to be used for deposition work by Chemetal. Chemetal has begun deposition of CNTD (controlled nucleation thermochemical decomposition) SiC coatings.

25989 (DSE/2538—1) **Development of a thin film polycrystalline solar cell for large scale terrestrial use. First quarterly progress report, July 1, 1976—September 30, 1976.** Meakin, J.D. (Delaware Univ., Newark (USA). Inst. of Energy Conversion). 25 Jan 1977. Contract EX-76-C-01-2538. 67p. Dep. NTIS, PC A05/MF A01.

The maximum power conversion efficiency achieved with a CdS/Cu_2S cell has been increased to 7.77% in actual sunlight testing. Further improvements are anticipated with a redesigned grid structure of 96% transmissivity. Films of mixed zinc cadmium sulfide have been vapor deposited. Initial photovoltaic cells made on these films show open circuit voltages up to 0.68 V. The early cells showed short circuit currents below the levels achieved with CdS/Cu_2S. An alternate technique for producing the surface Cu_2S film has been developed using a solid state reaction. The theoretical analysis of cell operation has been further refined.

25990 (ERDA/JPL/954331—77/3) **Silicon materials task of the low cost solar array project (Phase II). Seventh quarterly report, April 1, 1977—June 31, 1977.** Hopkins, R.H.; Davis, J.R.; Blais, P.D.; Rai-Choudhury, P.; Hanes, M.H.; McCormick, J.R. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Research and Development Center). Sep 1977. Contract NAS-7-100-954331. 68p. Dep. NTIS, PC A04/MF A01.

The objective of Phase II of this program is to investigate the effects of various processes, metal contaminants, and contaminant-process interactions on the performance of terrestrial solar cells. The majority of the effort this quarter was in three areas: (1) the growth, chemical analysis, and cell characterization of Czochralski ingots for processing studies, extension of the 4 Ω-cm p-type cell impurity data base, and impurity studies of n-base cells, (2) modification of equipment for improved electrical characterization, and (3) extension of mathematical modeling to predict solar cell efficiencies of contaminated devices as a function of impurity type and concentration.

25991 (NTIS/PS—77/0955) **Silicon solar cells. Volume 1. 1964-September 1976 (citations from the NTIS data base). Report for 1964-**

Sep 76. Smith, M.F. (National Technical Information Service, Springfield, Va. (USA)). Nov 1977. 255p. NTIS PC N01/MF N01.

Federally-funded research on silicon solar cell development related to doping, theory, design, fabrication, cost analysis, radiation effects, photovoltaic effects, semiconducting films, thin films, and coatings are covered. Both terrestrial and space applications are included. (This updated bibliography contains 250 abstracts, none of which are new entries to the previous edition.)

25992 (NTIS/PS—77/0956) **Silicon solar cells. Volume 2. October 1976—November 1977 (citations from the NTIS data base). Report for Oct 76—Nov 77.** Smith, M.F. (National Technical Information Service, Springfield, Va. (USA)). Nov 1977. 192p. NTIS PC N01/MF N01.

Studies from Government-sponsored research reports on silicon crystal growth, fabrication, and production on both a large and small scale are cited. The costs of fabrication methods are included. The performance and testing of these cells, as well as encapsulating materials, is covered. (This updated bibliography contains 187 abstracts, all of which are new entries to the previous edition.)

25993 (NTIS/PS—77/0958) **Silicon solar cells. Volume 2. 1976-November 1977 (citations from the Engineering Index data base). Report for 1976-Nov 77.** Smith, M.F. (National Technical Information Service, Springfield, Va. (USA)). Nov 1977. 127p. NTIS PC N01/MF N01.

Worldwide research on the development of solar energy conversion devices using silicon ribbons, sheets, films, crystals, and wafers is cited. The preparation, purity, crystal defects, and efficiency of these cells are covered. The economics of solar cell development is discussed. The effects of radiation and weathering on performance is included. (This updated bibliography contains 120 abstracts, 75 of which are new entries to the previous edition.)

25994 (PB—273038) **Cadmium stannate selective optical films for solar energy applications. Semi-annual progress report 1 Jan—30 Jun 75.** Haack, G.; Burton, L.C. (American Cyanamid Co., Stamford, Conn. Chemical Research Div.). Jul 1975. Contract NSF-AER73-07957. 38p. (NSF/RANN/SE/AER—73-07957/PR/75/2). NTIS PC A03/MF A01.

A modified post-deposition heat treatment has resulted in electrical sheet resistances below 1 ohm/square for sputtered cadmium stannate films. Spray coating equipment was installed which allows the preparation of cadmium stannate films with moderate sheet resistance at lower substrate temperatures (400C) than had been possible previously. The sputter technique has been used to deposit very thin CdS films (2-5 micrometers) onto cadmium stannate electrodes. The films are well crystallized and highly oriented. Micropinholes in the CdS layer cause short circuiting and low efficiencies in finished solar cells. The backwall efficiencies of Cd_2SnO_4/CdS/Cu_2S cells has been increased to 5.2% by improved cell lamination. High temperature stability (250C) of CdS cells with cadmium stannate substrates was found to be superior to that of standard metal substrate cells.

25995 (SAND—77-1269C) **Computer analysis of resistance and non-uniform illumination effects on concentrator solar cells.** Mitchell, K.W. (Sandia Labs., Albuquerque, N.Mex. (USA)). 1977. Contract EY-76-C-04-0789. 4p. (CONF-771201—4). Dep. NTIS, PC A02/MF A01.

From IEEE international electron devices meeting; Washington, DC, USA (5 Dec 1977).

A computer program has been developed to perform a two-dimensional matrix analysis of the voltage distribution in the top layer of concentrator solar cells in order to evaluate the important effects of top layer sheet resistance, contact grid geometry, and non-uniform illumination. The uniformity of illumination influences the cell efficiency through modifying the resistance losses in the cells. It is shown that introduction of lower top layer resistance (approximately 5 ohms/square) reduces the sensitivity of cell performance to illumination uniformity, which suggests important economic benefits for concentrator systems: reduced power loss (higher conversion efficiency) in solar cells at higher concentrations, and relaxed tolerances on illumination uniformity (lower concentrator cost).

25996 (TID—28183) **Development of a thin film polycrystalline solar cell for large scale terrestrial use. Progress report, July 1, 1976—September 30, 1976.** (Delaware Univ., Newark (USA). Inst. of Energy Conversion). Jan 1977. Contract EX-76-C-01-2538. 66p. NTIS.

The maximum power conversion efficiency achieved with a CdS/Cu_2S cell has been increased to 7.77% in actual sunlight testing. Further improvements are anticipated with a redesigned grid structure of 96% transmissivity. Films of mixed zinc cadmium sulfide have been vapor deposited. Initial photovoltaic cells made of these films show open circuit voltages up to 0.68 V. The early cells showed short circuit currents below the levels achieved with CdS/Cu_2S. An alternate technique for producing the surface Cu_2S film has been developed using a solid state reaction. The theoretical analysis of cell operation has been further refined. During the next quarter experiments will be conducted to improve the short circuit currents and enhance the efficiency of the mixed sulfide cells. The results of the theoretical analysis will be applied to optimizing the fill factor of CdS/Cu_2S cells of high conversion efficiency.

25997 Solar cell equipment with concentrating mirrors and radiator surfaces. Rex, D. (Technische Univ. Braunschweig (Germany, F.R.). Abt. fuer Raumflugtechnik). *Z. Flugwiss. Weltraumforsch.;* **1**: No. 13, 210-222(May 1977). (In German).

A new design for space solar generators is investigated in which solar radiation is focussed on the solar cells by cylinder-parabolic mirrors. The mirrors also act as radiator fins for cooling the solar cells. The interior area of such a panel (except the supporting structure), consisting of an array of radiating mirror fins and solar cells, is analysed with respect to geometry and thermal behaviour, also taking account of its structural stability. Results of the calculation show that by this concept the mass-to-power ratio of the interior area of a solar panel is reduced. Equally the area per power covered with solar cells is reduced to one third, from which advantages in cost can be expected. Constructive design of the entire panel is still to be carried out.

25998 Comparative performance of silicon and gallium arsenide solar cells on a high altitude sounding rocket. Thomas, N.L. (Lockheed Missiles and Space Co., Inc., Sunnyvale, CA); Chisel, D.M. pp 3-8 of Optics in solar energy utilization II . Selvage, C. (ed.). Palos Verdes Estates, CA; Society of Photo-Optical Instrumentation Engineers (1977).

From 20. annual SPIE technical symposium; San Diego, CA, USA (24 Aug 1976).

See CONF-760832—P1.

The use of sounding rockets for calibrating solar cells offers two principal advantages: (1) there is no effect due to the terrestrial atmosphere, and (2) the cells are recoverable immediately after the calibration. On March 30, 1976, twenty-nine n/p silicon and four p/n gallium arsenide solar cells were calibrated in space and successfully recovered from a NASA-Astrobee F rocket that reached a peak altitude of 230 km. Approximately 75 IV characteristic curves were generated for thirty-two of the cells to an accuracy of +-0.2 ma and +-0.2 mV. The short-circuit currents for these cells are presented for AM0 and AM1.

25999 Consideration of encapsulants for photovoltaic arrays in terrestrial applications. Cuddihy, E.F.; Carroll, W.F. (California Inst. of Tech., Pasadena). pp 16-22 of Optics in solar energy utilization II . Selvage, C. (ed.). Palos Verdes Estates, CA; Society of Photo-Optical Instrumentation Engineers (1977).

From 20. annual SPIE technical symposium; San Diego, CA, USA (24 Aug 1976).

See CONF-760832—P1.

Long-term survivability of photovoltaic arrays and components in terrestrial environments will require development of adequate protective systems. Highly considered are polymeric encapsulants, a method which was successfully employed in space and aerospace applications to protect critical electrical circuitry. To be employable, however, the polymer encapsulants must themselves be chemically and mechanically resistant to failure in terrestrial service. Chemical resistance includes stability to the degrading actions of ultraviolet light, oxygen, moisture and elevated temperatures in sun rich areas. Programs are underway to identify and develop chemically stable encapsulant candidates. Chemical considerations aside, mechanical failures of the encapsulants must also be avoided in array designs. Design considerations for avoiding mechanical failures of polymeric encapsulants are discussed with emphasis on biaxial properties, thermal fatigue, and anisotropy and nonhomogeneity of material properties. The general principles to be presented evolved from actual failures of polymeric materials in engineering applications. Also included are brief remarks on the permeability of polymer materials to atmospheric gases.

26000 GaAs solar cells for very high concentrations. James, L.W.; Moon, R.L. (Varian Associates, Palo Alto, CA). pp 23-29 of Optics in solar energy utilization II . Selvage, C. (ed.). Palos Verdes Estates, CA; Society of Photo-Optical Instrumentation Engineers (1977).

From 20. annual SPIE technical symposium; San Diego, CA, USA (24 Aug 1976).

See CONF-760832—P1.

For terrestrial applications, the cost of photovoltaic power must be reduced by orders of magnitude. The usual approaches to low cost cell fabrication have many unsolved problems. Specially-constructed AlGaAs/GaAs heterojunction solar cells operated with large factors of solar concentration have reduced the projected cell cost per watt to an economically feasible level. The electronics for a two-axis run following tracking system are also sufficiently inexpensive. Therefore the economic feasibility of a concentrator GaAs solar cell based terrestrial photovoltaic power system depends on the

development of low cost optics capable of high values of solar concentration.

26001 **Solar cell 'eyes' with self operating solar adjustment.** *Elektriker;* **15**: No. 9, 233(1976). (In German).

The present article describes a solar cell construction in which the solar cell of the solar movement is adjusted automatically without needing additional energy. In the normal case, a Fresnel lens concentrates the solar radiation on the photoelement. If as a result of the solar movement the focal point leaves the photoelement, it falls on a gas container and heats the gas. The gas expands and moves a piston, thus moving the solar cell in such a way that the focal point is on the photoelement again. The mechanism of the movement is described very clearly.

26002 **Physics of InP/CdS solar cells.** Shay, J.L. (Bell Telephone Labs., Holmdel, NJ); Wagner, S.; Bachmann, K.J.; Buehler, E. pp 800-803 of Physics of semiconductors. Fumi, F.G. (ed.). New York; Elsevier/North-Holland Inc. (1976).

From 13. international conference on physics of semiconductors; Rome, Italy (30 Aug 1976).

See CONF-760860—.

Studies of the energy band diagram of the InP/CdS heterojunction and studies of the nature and density of interfacial defects are described.

BIOMASS PRODUCTION AND CONVERSION

REFER ALSO TO CITATION(S) 25982, 26674

26003 **Utilization and disposal of wastes by photosynthetic bacteria.** Kobayashi, M. (Kyoto Univ.). pp 443-453 of Microbial energy conversion. Schlegel, H.G.; Barnea, J. (eds.). Elmsford, NY; Pergamon Press Inc. (1977).

From Microbial energy conversion symposium; Gottingen, F.R. Germany (Oct 1976).

See CONF-7610131—.

A model treatment plant was developed for treating wastes with a high organic content utilizing photosynthetic bacteria. The decontaminated sludge after treatment with photosynthetic bacteria, could be utilized as animal feed supplements and organic fertilizers. The process of utilizing photosynthetic bacteria for treatment of digested sludge holds great promise for the future.

26004 (CONF-780109—3) **Energy from biomass: an overview of environmental aspects.** Roop, R.D. (Oak Ridge National Lab., Tenn. (USA)). 1978. Contract W-7405-ENG-48. 15p. Dep. NTIS, PC A03/MF A01.

From Technology for energy conservation; Albuquerque, NM, USA (23 Jan 1978).

Recent literature regarding energy from biomass is reviewed in order to delineate environmental issues and suggest research needed for assessment of this energy option. Potential sources of biomass for conversion to energy include agricultural and forestry residues, municipal and industrial wastes, biomass plantations, and freshwater and marine grown plant material. The impacts of using wastes and of growing biomass for fuel are summarized. 39 references. (JSR)

26005 (COO/2991—19) **Anaerobic digestion technology. Quarterly progress meeting, Ithaca, New York, June 20—22, 1977.** (Dynatech R/D Co., Cambridge, Mass. (USA)). Nov 1977. Contract EY-76-C-02-2991. 136p. Dep. NTIS, PC A07/MF A01.

Summaries of the current status of research on anaerobic digestion technology are presented. The fourteen projects reported on range in subject matter from the fundamentals and mechanisms of anaerobic digestion to the construction and operation of demonstration plants. Separate abstracts were prepared for each summary of research progress. (JGB)

26006 (COO/2991—19, pp 5-6) **Effect of molecular structure on methane fermentability.** Speece, R.E. Nov 1977.

In Anaerobic digestion technology. Quarterly progress meeting, Ithaca, New York, June 20—22, 1977.

In order to evaluate the possibility of the use of anaerobic digestion for the treatment of petrochemical wastes, the effects of molecular structure on methane fermentation were studied. The toxicity of fifty-three petrochemicals of different structures to unacclimated methane cultures developed on an acetate substrate was assayed. Results showed a definite correlation of molecular structure and toxicity. (JGB)

26007 (COO/2991—19, pp 7-16) **Heat treatment of organics for increasing anaerobic biodegradability. Quarterly progress report, March 1, 1977—May 31, 1977.** Healy, J.; Owen, W.; Stuckey, D.; Young, L.Y.; McCarty, P.L. Nov 1977.

In Anaerobic digestion technology. Quarterly progress meeting, Ithaca, New York, June 20—22, 1977.

In studies on lignocellulose digestion and pretreatment alternatives, the digestibility of thermochemically treated alkali-lignin was monitored with an anaerobic serum bottle bioassay technique. Results indicate that approximately 14 percent of thermochemically treated lignin was converted to methane by an acclimated anaerobic microflora. The effects of heat treatment on the degradability of the nitrogenous constituents of bacterial cells in waste activated sludge was also studied. Data indicate that increased biodegradability can be achieved, but with substantial increases in the production of toxic substances. Preliminary results of aromatic biodegradability studies are discussed. (JGB)

26008 (COO/2991—19, pp 17-44) **Promoting faster anaerobic digestion: summary of progress and plans.** Finney, C.D.; Evans, R.S. II; Finney, K.A. (Cornell Univ., Ithaca, NY). Nov 1977.

In Anaerobic digestion technology. Quarterly progress meeting, Ithaca, New York, June 20—22, 1977.

Previous studies on the mechanism of methane production during anaerobic digestion have indicated that the third step in the process, the conversion of volatile acids to methane and CO_2, is rate-limiting. Evidence is presented to substantiate the phase-transfer rate-limiting theory, two aspects of which are discussed. The first is that transfer of the more soluble gaseous product, CO_2, through the bubble wall is rate-limiting. The second part is that under the condition of a high acid concentration, the gas production per bacterium becomes so rapid that the methane bacteria partially or completely smother themselves in their own bubble froth. (JGB)

26009 (COO/2991—19, pp 45-46) **Current status of an ERDA project "permselective membrance control of algal and wood digesters for increased production and chemicals recovery".** Gregor, H.P.; Cardenas, R. Nov 1977.

In Anaerobic digestion technology. Quarterly progress meeting, Ithaca, New York, June 20—22, 1977.

As part of the effort to increase methane production and separate industrial chemicals, plans are under way to evaluate ultrafiltration and other kinds of membranes for their applicability to anaerobic processes. Work at this time involves construction and start-up of the digesters and the concentration of a variety of algal feedstocks that will be frozen or stored in sufficient quantities for feedstock. (JGB)

26010 (COO/2991—19, pp 47-48) **Anaerobic fermentation of agricultural residues: potential for improvement and implementation. Fourth quarter progress report, March 2, 1977—June 15, 1977.** Jewell, W.J.; Davis, H.R.; Guest, R.W.; Price, D.R.; Gunkel, W.W.; Capener, H.R.; Casler, G.L.; Van Soest, P.J. Nov 1977.

In Anaerobic digestion technology. Quarterly progress meeting, Ithaca, New York, June 20—22, 1977.

Results of studies on the development of a simply designed reactor for rapid methane generation in small scale agriculture are summarized. The effects of the presence of solid materials on the rate of gas generation are also reported. (JGB)

26011 (COO/2991—19, pp 49-52) **ANFLOW treatment of municipal waste water.** Pitt, W.W. Jr.; Griffith, W.L. (Oak Ridge National Lab., TN). Nov 1977.

In Anaerobic digestion technology. Quarterly progress meeting, Ithaca, New York, June 20—22, 1977.

The ANFLOW, or ANaerobic upFLOW, process can be used for the direct anaerobic treatment of waste waters. This process consists of attaching microorganisms to conventional packing materials that have been specially modified and passing liquid waste waters upward through columns of such materials for treatment. The treated packing material, in each case, is contained within a continuous-upflow packed-bed bioreactor and operated anaerobically. The unit can be used both to provide waste water treatment and to produce fuel gas. The technology is being tested at a demonstration plant in the City of Oak Ridge. Preliminary results are reported.

26012 (COO/2991—19, pp 53-56) **Enhancement of methane production with activated carbon.** Spencer, R.R.; McGuire, H.E. Jr. Nov 1977.

In Anaerobic digestion technology. Quarterly progress meeting, Ithaca, New York, June 20—22, 1977.

The effects of powdered activated carbon on the anaerobic digestion of sewage sludge in well-controlled digesters are being evaluated. Initial studies were conducted to verify the beneficial effects of powdered activated carbon observed in earlier experiments. Then six different powdered carbons, representing a wide variety of physical and chemical properties, were added to the laboratory digesters. Subsequent experiments examined the effectiveness of the optimum carbon type at various concentrations and solids residence times. Research completed to this point clearly indicates the ability of powdered activated carbon to increase methane production in bench-scale anaerobic digesters. (JGB)

26013 (COO/2991—19, pp 57-62) **Best mixing concepts for refuse/sludge for ERDA's biogasification project.** Swartzbaugh, J.T. (Systems Tech. Corp., Xenia, OH). Nov 1977.

In Anaerobic digestion technology. Quarterly progress meeting, Ithaca, New York, June 20—22, 1977.

In order to ensure effective operation of an anaerobic digester, it is essential that digester contents be adequately mixed. Data from previous pilot plant studies are being used to evaluate different methods of mixing slurries of municipal wastes. (JGB)

26014 (COO/2991—19, pp 63-76) **Design and analysis of a cow manure heat exchanger for the 100,000 gallon methane-producing digester in Monroe, Washington.** Reichmuth, H.S.; Baylon, D.; Smith, K.D. Nov 1977.

In Anaerobic digestion technology. Quarterly progress meeting, Ithaca, New York, June 20—22, 1977.

Design criteria for the heat exchanger to be used in the Monroe, Washington digesters are outlined. Heat exchange properties of cow manure slurries were measured. Plans are under way for operational testing of the segmented tube counterflow heat exchanger that has been constructed. (JGB)

26015 (COO/2991—19, pp 77-84) **A.S.E.F. solid waste to methane gas, Pompano Beach, Florida. Project progress report No. 22.** (Jacobs Constructors, Inc., Chicago). Nov 1977.

In Anaerobic digestion technology. Quarterly progress meeting, Ithaca, New York, June 20—22, 1977.

Project progress from April 16, 1977 to May 15, 1977 is summarized. Data on engineering, purchasing, and construction management/construction phases of the program are given. A flowsheet of the system, which will convert solid refuse to methane, is included. (JGB)

26016 (COO/2991—19, pp 85-98) **Monfort waste conversion demonstration. Progress report, April 1, 1977—June 4, 1977.** Turk, M. Nov 1977.

In Anaerobic digestion technology. Quarterly progress meeting, Ithaca, New York, June 20—22, 1977.

Progress for the period, April 1, 1977 through June 4, 1977, is reported on the evaluation of the operation of an anaerobic fermentor under field conditions, utilizing residues from a dirt feedlot in their normally collected conditions. Startup methods and adaptation of the fermentor to operating conditions at 135°F/57.2°C, while maintaining low volatile acid content, are being evaluated. Operating problems are discussed. (JGB)

26017 (COO/2991—19, pp 99-110) **Anaerobic fermentation of animal and crop residues: summary. Quarterly progress report (second), April 1, 1977—June 10, 1977.** Hashimoto, A.G.; Chen, Y.R.; Prior, R.L. (U.S. Meat Animal Research Center, Clay Center, NE). Nov 1977.

In Anaerobic digestion technology. Quarterly progress meeting, Ithaca, New York, June 20—22, 1977.

Experiments on density, specific heat and rheological properties of the fermentor influent and effluent slurries are continuing. Fermentor operational problems are discussed. Amino acid yields are given, and the kinetics of substrate utilization are discussed. (JGB)

26018 (COO/2991—19, pp 111-118) **Biological conversion of biomass to methane.** Pfeffer, J.T. (Univ. of Illinois, Urbana). Nov 1977.

In Anaerobic digestion technology. Quarterly progress meeting, Ithaca, New York, June 20—22, 1977.

Progress is reported on studies to determine the desired reactor type to maximize gas production. Experiments are described and data presented on experiments with complete mixed, two-stage, and plug flow reactors. Substrate being used is shredded computer paper plus a small quantity of sewage sludge added for microorganism seed and micronutrients. Preliminary results indicate that the complete mix reactor exhibits better methane production than either of the other two reactor designs. Results of experiments on methane production from pilot plant units consisting of completely mixed reactors using different beef feed lot manure substrates at varying loading rates are reported. (JGB)

26019 (COO/2991—19, pp 119-130) **Economics of carbon dioxide removal.** Ashare, E.; Wise, D.L.; Wentworth, R.L. Nov 1977.

In Anaerobic digestion technology. Quarterly progress meeting, Ithaca, New York, June 20—22, 1977.

Fuel gas obtained from the anaerobic digestion of waste materials usually needs to be treated before being transmitted in existing pipeline systems. A preliminary survey of the available gas purification technologies indicated that viable methods for the treatment of digester gas include physical absorption, chemical absorption, and adsorption processes. Cost estimates were obtained for the Selexol process, a physical absorption system using the dimethyl ether of polyethylene glycol as the solvent, and the chemical absorption Benfield, Catacarb, and Amine-Guard processes which utilize potassium carbonate, a potassium salt solution, and monoethanolamine, respectively, as the solvents. Cost data were also obtained for the molecular sieve adsorption Marsco process. In addition, two non-proprietary processes, namely physical absorption water scrubbing and a chemical absorption aqueous phosphate buffer system, were designed by computer simulation. From the results of an economic and technical analysis of the seven systems, water scrubbing was found to be the most economical system for the treatment of digester gas with the flow streams considered. The commercial chemical absorption systems were less economical due to high heat requirements for solvent regeneration. Among the chemical absorption processes, the hot potassium systems were found to be more economical than the amine system. The molecular sieve adsorption process was economically similar to the chemical absorption process. The cost analyses in this study were based on assumption of no recovery of the CO_2 by-product. It was found that credits for the recovery of the CO_2 could be significant.

26020 (ERDA/USDA—19464/76/FR-3) **Energy relationships for a 320-acre Iowa farm: an attempt to increase production of grain and meat while rendering the farm energy self-sufficient by generating methane through anaerobic fermentation of residues.** Smith, R.J.; Miranowski, J.A.; Vetter, R.L. (Iowa State Univ. of Science and Technology, Ames (USA)). Sep 1976. 180p. Dep. NTIS, PC A09/MF A01.

Discussion is presented under the following subject headings: characteristics of a typical central Iowa farm; economic analysis; energy use on the farm; energy recovery through anaerobic digestion; digester design for a central Iowa farm; agricultural residues as feed resources; and, bibliography. Subjects of the two appendices are energy for fieldwork bulletins and computer program for wood, stressed-skin digester top. The economic feasibility of an on-farm methane-digester system, premised upon the assumptions of this analysis, is questionable within a responsible range of energy-price rises. It is pointed out that the digester system might become feasible under specific circumstances. (JGB)

26021 (LBL—5275) **Cellulose, food and energy.** Wilke, C.R. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Nov 1977. Contract W-7405-ENG-48. 44p. (CONF-7608115—1). Dep. NTIS, PC A03/MF A01.

From International congress on engineering and food; Boston, MA, USA (9 Aug 1976).

The potential of cellulose as a source of energy and food is reviewed with consideration of raw material sources, processing methods, and economics. A tentative scheme for production of Torula yeast and ethanol from sugars produced by enzymatic hydrolysis of cellulose is described.

26022 (LBL—6351) **Study of the fermentation of xylose to ethanol by fusarium oxysporum.** Batter, T.R.; Wilke, C.R. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Jun 1977. Contract W-7405-ENG-48. 106p. Dep. NTIS, PC A06/MF A01.

Using pure xylose as a carbon source, the optimum temperature for growth was found to be 30°C and the optimum pH was found to be 5. The ethanol yield factor was determined to be 0.41 g ethanol/g xylose fermented. The cell mass yield factor was found to be 0.12 g cell mass/g xylose fermented. Kinetic growth data indicate that growth is not exponential, but rather it appears to be linear showing that the increase in the cell mass of the culture occurs at a constant rate. Studies on the effect of increasing ethanol concentrations on the growth of the organism show that decreased growth rates are apparent at concentrations of ethanol greater than 1.5% by wt, and growth is completely halted at concentrations greater than 4.1% by wt. Batch data also indicate that a growth associated inhibitory substance, as yet unidentified, is also present resulting in a cessation of fungal growth before all xylose is utilized. Fermentation studies were also conducted using a mixture of sugars obtained from the dilute acid hydrolysis of wheat straw. Preliminary results indicate that a process involving fermentation by F. oxysporum of sugars produced by acid hydrolysis and fermentation by S. cerevisae of the sugars produced by enzymatic hydrolysis would yield 117% more enthanol than the fermentation of the enzymatic hydrolysis sugars only. Due to the low growth rate of the organism, further development will be necessary to improve the economic feasibility of the xylose fermentation.

26023 (SRO—0888-2) **Multidisciplinary research program directed toward utilization of solar energy through bioconversion of renewable resources. Progress report.** Finnerty, W.R. (Georgia Univ., Athens (USA)). Nov 1977. Contract EY-76-S-09-0888. 75p. Dep. NTIS, PC A04/MF A01.

Individual abstracts were prepared for the three programs, A, B, and C. (JGB)

26024 (SRO—0888-2, pp 2-11) **Genetic selection, physiological basis of vigor, tissue culture.** Brown; Steinbeck. Nov 1977.

In Multidisciplinary research program directed toward utilization of solar energy through bioconversion of renewable resources. Progress report.

Techniques were developed for mass cloning American sycamore (Platanus occidentalis) using single buds from dormant and active twigs of one- and two-year-old sprouts and young trees for use in physiological studies and for multipling selected genotypes in clone banks. Strong positive correlations were obtained between callus formation and growth of cells (fresh and dry weights) on a defined basal medium with the growth performance of 5-year-old trees in the field previously selected on the basis of phenotypic expression of vigor (slow and fast growing clones). Weak positive correlations were obtained between callus growth and vigor of repeatedly coppiced clones from putative fast and slow growing field selections (paired observations from the same field plots). Tissue culture explants were all taken at the distal, third internode from one-year-old sprouts growing on 10-year-old root stocks. The trees had been harvested three previous times at 3-year-intervals. A mixed plantation of Alnus glutinosa and sycamore was established at a 4 x 8 foot spacing to study the future effects of the nitrogen fixing European black alder on total biomass production. Seasonal levels of reserve foods (sugars and starch) were followed in root stocks of American sycamore to learn more about the pattern of carbohydrate recycling in repeated harvested (coppiced) young plantations. Sporadic root differentiation was obtained on sterile x-sectional stem discs of sycamore in vitro after testing 25 various combinations of IAA and cytokinin. No intact plantlets have been formed to date, but studies are still in progress. Anther cultures of sycamore and cottonwood were attempted on Gresshoff and Doy's and Nitsch's haploid media. Some callus was observed in various cultures, but no haploid plantlets were differentiated in these early attempts.

26025 (SRO—0888-2, pp 12-60) **Biochemical basis of paraquat induced oleoresin production in pines.** Finnerty, W.R. Nov 1977.

In Multidisciplinary research program directed toward utilization of solar energy through bioconversion of renewable resources. Progress report.

Data collected from both field and laboratory studies during 1977 confirm and extend those observations and conclusions drawn from the data reported in 1976. Soluble metabolites, carbohydrates, keto acids, amino acids, and peroxyacids are mobilized when tissues of P. elliottii are injured. Little qualitative or quantitative difference between control and paraquat-treated tissue mascerates or cut controls and paraquat-treated intact field grown 5-year old trees were observed during these studies. Non-cut controls were qualitatively and quantitatively different from the injured trees. Seasonal fluctuations observed in untreated 5-year old pine trees indicate that comparable mobilization of carbon accompanies resin acid synthesis under natural conditions. The most pronounced differences between cut and paraquat-treated tissues was the apparent inability of paraquat-treated material to regulate amino acid metabolism over the long term. In composite, these data would indicate a mobilization of starch, with accompanying increased pool sizes of reducing sugars, keto acids, and amino acids which appeared to be available for resin acid synthesis. Paraquat treatment did not alter the percent composition of individual resin acids. Thus, paraquat apparently affected the rate of resin acid synthesis, but did not appear to alter the normal biosynthetic pathway for resin acid synthesis. Paraquat may effect both the rate and amount of monoterpenes produced by P. elliottii. Loss of up to 90% of the ^{14}C fixed by volatization following paraquat treatment could be indicative of loss of monoterpenes.

26026 (SRO—0888-2, pp 61-73) **Biochemistry of methanogeness.** Peck; Ljungdahl. Nov 1977.

In Multidisciplinary research program directed toward utilization of solar energy through bioconversion of renewable resources. Progress report.

Cellulytic bacteria, cellobiose fermentors, and methanogenic bacteria were isolated from established anaerobic cellulose—methane fermentations and employed to partially reconstitute highly active cellulose methane fermentations. These mixed cultures will be utilized as model systems to study the parameters required for maximum production of CH_4, H_2, and chemical feedstocks such as acetate, formate, ethanol, propionate, etc. Progress is reported in studies on the biochemistry of enzymes involved in one and two carbon metabolism, with emphasis being placed on the role of selenium and tungsten in the active site of formate dehydrogenase and the possible role of formate and formate dehydrogenase in methane formation. The bioenergetics of methane formation was investigated utilizing the hydrogenase/fumarate reductase couple for the detection of cell-free electron transfer coupled phosphorylation and the isolation of low molecular weight electron transfer proteins. The goal of this aspect of the research is to obtain an understanding of the physiology and pathway of methane formation in methanogenic and related anaerobic bacteria.

26027 **Solar biomass energy: an overview of U.S. potential.** Burwell, C.C. (Oak Ridge National Lab., TN). *Science;* **199**: 1041-1048(10 Mar 1978).

The U.S. annual biomass production for food, lumber, paper, and fiber, if used exclusively for energy, would provide 25 percent of current energy requirements. The collection of unharvested wood residues and cull trees for direct use as fuel for small nearby space-heating applications, especially for peak winter conditions, is an important near-term solar energy opportunity. Improved management of hundreds of millions of acres of productive forest land is an important opportunity for the long term. Harvest of cropland residues for energy values, new biomass production using intensive short-rotation silviculture, resubstitution of natural products for petroleum-based synthetics, and forest management for large-scale production of electricity and synthetic fuels are judged to be less appropriate directions for the U.S. energy system to take.

26028 **Biomass production from animal wastes by photosynthetic bacteria.** Ensign, J.C. (Univ. of Wisconsin, Madison). pp 455-482 of Microbial energy conversion. Schlegel, H.G.; Barnea, J. (eds.). Elmsford, NY; Pergamon Press Inc. (1977).

From Microbial energy conversion symposium; Gottingen, F.R. Germany (Oct 1976).

See CONF-7610131—.

The residue from centrifugation of cow and poultry manures which have been digested anaerobically contain, respectively, 10.2 and 31% of their dry weights as protein. The supernatant fluids contain high concentrations of acetic, propionic, and butyric acids. A mixed culture of photosynthetic bacteria grow on substrates in these liquids when exposed to light. The cell yields as protein are 20 and 24%, respectively, of the dry weight of dry cow and chicken manure. The total production of protein resulting from anaerobic fermentation and growth of photosynthetic bacteria is 30.2% of the dry weight of cow manure, 55% of the dry weight of chicken manure.

PHOTOCHEMICAL AND THERMOCHEMICAL CONVERSION

REFER ALSO TO CITATION(S) 25986

PHOTOVOLTAIC POWER PLANTS

26029 (EPRI-ER—589-SR) **Perspectives on utility central station photovoltaic applications.** DeMeo, E.A.; Bos, P.B. (Electric Power Research Inst., Palo Alto, Calif. (USA)). Jan 1978. 54p. Dep. NTIS, PC A04/MF A01.

This report develops nominal cost and performance goals for solar photovoltaic conversion devices intended for large-scale electric utility applications. The objective is to provide an improved basis for establishing research and development priorities for photovoltaic devices and conversion concepts. Comparisons are made among a number of generic power plant conceptual designs, with the aid of an array design parameter that is defined to include array-area-related costs, overall power plant efficiency, and average available insolation. The analysis indicates that flat plate approaches without concentration or tracking have good prospects for commercial viability if device conversion efficiencies near 10 percent can be combined with installed device costs under $\$20/m^2$ ($\$2/ft^2$) and device lifetimes in excess of 20 years. Thin-film approaches have potential for achieving these cost and performance goals because of low material content and potentially low fabrication costs. Very high efficiency devices coupled with concentrations in excess of about 100:1 represent a viable alternative if sufficiently high conversion efficiencies (25 percent or more) can be achieved. Such devices are likely to be expensive, but high concentration may make their costs acceptable. Several device types and converter approaches exist or have been proposed that have potential for reaching these efficiencies. In contrast to flat plate approaches, however, high-concentration approaches may have the disadvantage of requiring active cooling. Approaches employing low-to-medium concentration appear to have limited potential for large-scale applications. Required efficiencies are likely to be comparable to those needed for high-concentration approaches, but the concentration ratios are not likely to be high enough to make the photovoltaic device costs tolerable.

26030 **Solar Electric Energy Development: an energy policy alternative.** Palm Springs, CA; Canada-West (1977). 59p. (NP—22758).

A ten-year program to build a public solar power project having an electric energy output equal to the Nation's current total electric power production from all sources is described. Various issues in the attainment of such a National challenge are discussed in specifics in order to clearly identify the problems and a solution. The trends in the two principal costs in major electric power plants, fuel cost and plant investment capital costs, show that both oil-fired and nuclear-fired electric costs have already departed the era of the low-priced energy necessary to America's lifestyle. On the other hand, the technology to convert abundant no-fuel-cost solar energy to electricity is well in hand. The impetus of large-production demands

on the lowering of such solar plant costs has already established the trend toward a solar era of low utility bills and energy abundance. A net outlay of about $400 billion extending over a ten-year building program can result in a 1.2-million-megawatt solar-electric plant. This could occupy a patch of our southwestern desert only 76 miles square. Moreover, the oil that would be required to match the plant's solar-electric generation, at our current oil-steam plant efficiencies, is more than the 1976 oil production of Saudi Arabia and the Arab Emirates. Such an "oil equivalent" solar energy discovery makes that 3.7 million acres of our desert one of the richest "oil finds" in the World, and this without impairment of our environment.

26031 **Development of a satellite solar power station.** Glaser, P.E. (Arthur D. Little, Inc., Cambridge, MA). pp ix-xxvi of Optics in solar energy utilization II . Selvage, C. (ed.). Palos Verdes Estates, CA; Society of Photo-Optical Instrumentation Engineers (1977).

From 20. annual SPIE technical symposium; San Diego, CA, USA (24 Aug 1976).

See CONF-760832—P1.

The options for converting solar energy in space are discussed including photovoltaic conversion and thermal-electric conversion. The options for transmitting the power to earth are compared (microwave radiation, laser radiation, and focusing mirrors). An SSPS baseline design is outlined based on photovoltaic conversion with concentrators and microwave power transmission. SSPS transportation, assembly, and maintenance are discussed. Environmental implications and economic and social implications of an SSPS are considered. (WHK)

SOLAR THERMAL POWER PLANTS

REFER ALSO TO CITATION(S) 26031

26032 (CONF-780216—2) **Value of energy storage for direct-replacement solar thermal power plants.** Anderson, T.D.; Kaplan, S.I.; Wilson, J.V. (Oak Ridge National Lab., Tenn. (USA)). 1978. Contract W-7405-ENG-26. 29p. Dep. NTIS, PC A03/MF A01.

From SERI storage applications workshop; Golden, CO, USA (14 Feb 1978).

The general objective of the study was to develop information on energy storage requirements for solar thermal power plants as an aid to planning and implementing the research and development work. The specific objectives of the study are: (1) to derive cost targets (or what can be afforded) for energy storge systems over a range of applications of direct-replacement solar-thermal power plants; and (2) to determine the amount of energy storage required for a given cost of storage. The utility applications considered are base-load (100% demand factor) and intermediate-load (50% and 25% demand factor). Locations examined are Inyokern, Chicago, and Philadelphia. The locations selected are intended to provide a representative sampling of U.S. conditions with respect to both solar resources and utility system load patterns. Backup capacity, economic tradeoffs, demand factors, and economic analysis are discussed. It is concluded that the value of energy storage is strongly dependent on the cost of the solar steam supply system and on the cost of backup fuel. For a given set of these cost factors, the optimum amount of energy storage is a function of the cost of storage. For the range of cost conditions and power plant locations considered in this study, the maximum amount of storage capacity required was estimated to be 15 kW . hr/kW for a base-load plant located at Inyokern. For intermediate-load plants, the optimum amount of storage capacity was estimated to be less than 6 kW . hr/kW. Other studies indicate that intermediate-load solar power plants have the best economic potential. It is concluded, therefore, that the energy storage R and D program should focus on storage systems of relatively low capacity, i.e., less than 6 kW . hr/kW. (WHK)

26033 (SAND—77-8278) **STEAEC: Solar Thermal Electric Annual Energy Calculator documentation.** Woodard, J.B.; Miller, G.J. (Sandia Labs., Livermore, Calif. (USA)). Jan 1978. Contract EY-76-C-04-0789. 78p. NTIS, PC E 04/MF A01.

The Solar Thermal Electric Annual Energy Calculator (STEAEC) is a computer model which estimates the annual performance of a solar thermal electric power plant. Written in FORTRAN IV for the CDC 6600, STEAEC is a quasi-steady state model with a constant (but user-variable) time step. Factors such as energy losses and delays incurred in start-up, effects of ambient weather conditions on plant operation and efficiency, effects of hold time and charge and discharge rates on deliverable energy in storage, subsystem maximum and minimum power limits, and auxiliary power requirements are taken into account in the computation of the annual electrical output of the plant. Default parameters may be easily modified through the use of NAMELIST inputs.

CENTRAL RECEIVER

REFER ALSO TO CITATION(S) 26075

26034 (ORO/5178—78-1) **Liquid metal cooled solar central receiver feasibility study and heliostat field analysis. Part I. Liquid sodium cooled central receiver system conceptual design. Final report.** Vant-Hull, L.; Coleman, G.C.; Springer, T.; Friefeld, J. (Houston Univ., Tex. (USA). Solar Energy Lab.). Oct 1977. Contract EG-76-G-03-1426. 162p. Dep. NTIS, PC A08/MF A01.

A conceptual design for a 100 MWe Solar Tower System employing liquid sodium as a heat transfer fluid and as a storage medium is generated. This design intentionally parallels the current commercial baseline design for a water/steam transfer fluid in order to enhance comparisons between the two approaches and to maximize the application of the limited funds in this study to the unique features of the liquid sodium system. Heat transfer at the receiver and the steam generator were considered in detail. Components for the liquid sodium loop currently under test on development were identified for a 10 MWe pilot plant and a 100 MWe demonstration plant. Economic comparisons with the MDAC water/steam receiver are favorable.

26035 (SAN/1111—76-7) **Central receiver solar thermal power system: collector subsystem. Final report.** (Boeing Engineering and Construction, Seattle, Wash. (USA)). 15 Aug 1977. Contract EY-76-C-03-1111. 154p. Dep. NTIS, PC A08/MF A01.

The preliminary design and performance testing of the heliostat subsystem for a 10 MW/sub e/ central receiver Pilot Plant are described. Circular membrane reflectors formed with aluminized polyester film, direct sunlight to the central receiver. Transparent air-supported plastic enclosures protect the lightweight reflectors from the environment. Reflectors are individually aimed with a 2-axis gimbal, driven by digital-controlled stepper motors. Minicomputers, located in a central control building, provide signals to the stepper motors. Three heliostats and a drive and control assembly were fabricated and tested to provide design data and verification of the preliminary design. In addition, an extensive evaluation program was conducted on the key plastic materials used in the protective enclosure and reflector. Performance and environmental exposure tests on large-scale heliostats were conducted over an 8-month period at a Boeing desert test site in northeast Oregon. Environmental exposure tests on the same heliostats are presently planned to continue through March, 1978. Principal objectives of this test were to determine optical performance, demonstrate operation of the drive and control assembly in the various operational modes, and verify survivability of hardware in the environment. Plastic materials evaluation tests have included measurement of mechanical and optical properties, creep, chemical exposure, cleanability, accelerated simulated sunlight, and actual desert sunshine exposure tests. The latter test was conducted at two different locations in the southwest (Albuquerque, N.M., and China Lake, CA), and at Boardman, Oregon. (WHK)

26036 **Development of solar tower program in the United States.** Vant-Hull, L.L. (Univ. of Houston, TX). pp 104-110 of Optics in solar energy utilization II . Selvage, C. (ed.). Palos Verdes Estates, CA; Society of Photo-Optical Instrumentation Engineers (1977).

From 20. annual SPIE technical symposium; San Diego, CA, USA (24 Aug 1976).

See CONF-760832—P1.

With strong governmental support and broad based public approval, the United States solar energy program has expanded rapidly in the last few years. In particular, we have traced the history and development of the solar tower from an idea in 1969 through first federal funding in 1973, to a program to initiate pilot plant construction in 1976. About 3,000 heliostats will reflect sunlight onto a central receiver, in which 500°C steam will be generated to drive a turbo-generator. With this 10 MWe plant scheduled to feed electricity into a utility grid in 1980, a 50-100 MWe demonstration plant is proposed to be on line in 1985.

26037 **Educated ray trace approach to solar tower optics.** Vant-Hull, L.L. (Univ. of Houston, TX). pp 111-120 of Optics in solar energy utilization II . Selvage, C. (ed.). Palos Verdes Estates, CA; Society of Photo-Optical Instrumentation Engineers (1977).

From 20. annual SPIE technical symposium; San Diego, CA, USA (24 Aug 1976).

See CONF-760832—P1.

An approach to the analysis of the optical system of the solar tower concept, which is designed to provide maximum design information, is described. By inputing all quantities in terms of angles or dimensionless ratios the results remain relatively scale independent. First the power redirected from the heliostat field to the central receiver is computed, then solar images are projected from each heliostat to the central receiver and interception factors are obtained. This information allows one to size the central receiver, to enhance performance by redistributing heliostats in the field, and finally to define the rim angle of the field. The procedure for this step by step

definition of the solar tower optical system results in optimal heliostat fields, receiver flux distributions and diurnal power curves.

DISTRIBUTED COLLECTOR

26038 (DOE/JPL/1060—1) **Projection of distributed-collector solar-thermal electric power plant economics to years 1990—2000.** Fujita, T.; El Gabalawi, N.; Herrera, G.; Turner, R.H. (Jet Propulsion Lab., Pasadena, Calif. (USA)). Dec 1977. Contract EX-76-A-29-1060. 91p. Dep. NTIS, PC A05/MF A01.

A preliminary comparative evaluation of distributed-collector solar thermal power plants has been undertaken by projecting power plant economics of selected systems to the 1990 to 2000 time frame. The selected systems include: (1) fixed orientation (non-tracking) collectors with concentrating reflectors and vacuum tube absorbers, (2) one-axis tracking linear concentrators including parabolic trough and variable slat designs, and (3) two-axis tracking parabolic dish systems including concepts with small heat engine-electric generator assemblies at each focal point as well as approaches having steam generators at the focal point with pipeline collection to a central power conversion unit. Comparisons are presented primarily in terms of energy cost (mills/kWh) and capital cost over a wide range of operating load factors. Sensitivity of energy costs for a range of efficiency and cost of major subsystems/components is presented to delineate critical technological development needs. The baseline central receiver or power tower systems using state-of-the-art 1000°F steam Rankine technology is used as a reference case for making comparisons of the selected distributed collector systems.

TOTAL ENERGY AND HYBRID SYSTEMS

26039 (TID—28013) **Conceptual design Solar Total Energy Large Scale Experiment number 1. Final report.** (TRW Energy Systems Group, Redondo Beach, Calif. (USA)). 21 Oct 1977. Contract EG-77-C-04-3989. 360p. Dep. NTIS, PC A16/MF A01.

The analyses which resulted in a recommended demonstration system concept for the production of electricity and thermal energy to supply a specified portion of the needs of a five-building complex of living quarters and administration buildings at the U.S. Army's Fort Hood, Killeen, Texas, are presented. The system selected includes 100,000 square feet of single-axis parabolic trough collectors; a packed bed thermocline heat storage system using Therminol 66 heat transfer fluid; a 450-kW Rankine cycle power system using single or multiple parallel toluene-driven turbines; and absorption refrigerators with lithium bromide. An in-depth analysis of the systems requirements, the conceptual design, a performance analysis, and the operational and test and development plans are presented. (WHK)

OCEAN THERMAL GRADIENT POWER PLANTS

26040 (COO/2641—3) **Dynamic models of falling film evaporators for ocean thermal energy conversion plants.** Hetyei, S.A.; Neuman, C.P. (Carnegie-Mellon Univ., Pittsburgh, Pa. (USA)). Jun 1977. Contract EY-76-S-02-2641. 52p. Dep. NTIS, PC A04/MF A01.

The pertinent physical laws of heat transfer and mass balance are applied to develop lumped parameter, dynamic and steady-state models for shell-and-tube evaporators incorporating falling films. The dynamic evaporator model is specified by three ordinary differential equations and one algebraic equation with two time-delays. It is shown that, in the steady-state, this dynamic model reduces to the steady-state evaporator model previously developed. It is demonstrated that the dynamic evaporator model is stable for perturbations around an equilibrium operating point. Provision is made for incorporating the data emerging from the CMU/OTEC Laboratory in the evaporator models formulated in this report. The effect of the recycle ratio sigma = mass rate of liquid flow from bottom of tube)/(mss rate of liquid flow into top of tube) on the heat transfer coefficient of the evaporating working fluid (ammonia) is noted. In the current phase of the research, the dynamic evaporator model is being incorporated with the component models developed earlier to assemble a simulation model of the power cycle of an OTEC plant. The power cycle model will be simulated on the digital computer to ensure that the component models adequately characterize experimentally observed data. The objective of this research is to develop simulation models of the OTEC power cycle as tools of power cycle and control system design and optimization.

26041 (PB—269283) **Ocean thermal energy conversion: resource, ecological and environmental studies. Final technical report.** Wolff, P.M.; Hubert, W.E. (Ocean Data Systems, Inc., Monterey, Calif. (USA)). Mar 1976. Contract NSF-C1020. 102p. NTIS PC A06/MF A01.

This report maps ocean areas around the North American continent where thermal structure is favorable for operation of Ocean Thermal Energy Conversion (OTEC) plants. Information is provided on the occurrence of severe storms accompanied by high winds and wave conditions, as well as ocean current patterns that are characteristic of these areas.

SOLAR RADIATION UTILIZATION

SPACE HEATING AND COOLING

REFER ALSO TO CITATION(S) 25982, 25985, 26039, 26079, 26080

26042 (AD-A—042178) **Market evaluation study: solar heating and domestic hot water heating in DOD buildings. Final report.** Windingland, L.M.; Martel, C. (Army Construction Engineering Research Lab., Champaign, Ill. (USA)). Jul 1977. 30p. (CERL-TR-E—114). NTIS PC A03/MF A01.

This study assesses the potential market for combined solar space heating and domestic hot water heating in Department of Defense (DOD) buildings. The study considers eight building categories: family housing, bachelor enlisted quarters, bachelor officers' quarters, administration, training, operational, community support, and recreational, which together contain 683 million sq ft (61.5 million m2), or 40 percent of the DOD inventory. All buildings were assumed to be oil heated. The buildings were grouped by climatological/solar regions, and the loads for each building type were determined by using the Energy Utilization Index (EUI) method. Solar system performance in each region was obtained by using the U.S. Army Construction Engineering Research Laboratory universal curve method. The life-cycle costs of providing solar space heating and domestic hot water heating were analyzed, and the DOD market potential for installed solar system costs of $9, $15, and $20 per square foot were determined. The study shows that at an estimated initial fuel cost of $3.50 MBtu for oil heating, a 10 percent cost of money, and an 8.5 percent overall fuel inflation factor, solar systems for space heating and domestic hot water heating become economically feasible when installed system costs are $14/sq ft (150/sq m. When installed system costs reach $9/sq ft ($97/sq m., the market potential becomes 172 million sq ft (15.5 million sq m.) of solar collectors. The study also shows the largest potential market at these economic conditions to be family housing, which contains a total of 102 million sq ft(9.2 million sq m.

26043 (CONF-770246—) **Solar energy-uses-systems-experience symposium and roundtable conference.** (Arbeitsgemeinschaft Solarenergie e.V., Essen (Germany, F.R.)). 1977. vp. (In German). NTIS (US Sales Only), PC A05/MF A01.

From Sonnenenergie) Anwendungen, Systeme, Erfahrungen; Essen, F.R. Germany (4 Feb 1977).

Separate abstracts were prepared for the 15 papers presented. (WHK)

26044 (CONF-771229—(Summ.)) **Solar heating and cooling demonstration program contractor's review. Summary and analysis of workshop and panel sessions.** Christensen, D.L. (Alabama Univ., Huntsville (USA). Kenneth E. Johnson Environmental and Energy Center). Dec 1977. Contract EC-78-C-01-4131. 43p. Dep. NTIS, PC A03/MF A01.

From Solar heating and cooling demonstration program contractors review; New Orleans, LA, USA (5 Dec 1977).

The Solar Heating and Cooling Demonstration Program Contractors' Review was held in New Orleans, Louisiana, during December 5 to 7, 1977. This Review was sponsored by the U.S. Department of Energy, Office of Solar Applications and supported by the contractual efforts of PRC Energy Analysis Company and The University of Alabama in Huntsville. The Proceedings containing all available papers and presentations were made available at the time of the Review. This Workshop Summary contains the results and summaries of the five workshops and panel session held on Wednesday, December 7, the final day of the program. The workshops reflected much of the interests and concerns of the various attendees and generally represent a summary of the overall program. The workshops included: (1) design concepts, philosophy and techniques; (2) installation, construction and hardware procurement; (3) operational and performance factors; (4) economic, environmental, societal and institutional issues; and (5) overview of National Demonstration Program.

26045 (COO/2769—2) **Solar house heating system using reflective pyramid optical condensing system. Final report. Evaluation of performance, June 1, 1975—December 31, 1976.** (Wormser Scientific Corp., Stamford, Conn. (USA)). Nov 1977. Contract EY-76-C-02-2769. 87p. Dep. NTIS, PC A05/MF A01.

The evaluation program for the pyramid optical condensing system is described. First, the prototype system, previously built on Westover Road, Stamford, Connecticut, was upgraded, instrumented, and evaluated. It was found to perform essentially as expected, but the open construction shown was found to have problems. A

fully enclosed model Pyramidal Optics house was built by Better Homes of Delaware near Rehoboth, Delaware. The solar system was instrumented as described. After a number of significant improvements were made in the optical concentrating system and the flat plate receiver assembly, the system was monitored throughout the winter of 1976/1977 and found to perform very well. The solar contribution to heating amounted to 70% during the severe winter months and is expected to exceed 80% throughout the year. The Pyramidal Optics system has been found to have a number of economic and operational advantages.

26046 (COO/4511—2) **CSU/DOE solar energy research program. Monthly progress report, November 1977.** (Colorado State Univ., Fort Collins (USA). Solar Energy Applications Lab.). 15 Dec 1977. Contract EG-77-S-02-4511. 256p. NTIS, MF A01.

Portions of document are illegible.

Short summaries of progress on individual research tasks are presented. Tasks include research on solar space heating and cooling, solar water heating, silicon solar cells, solar supplement to laundry drying, and stratified thermal storage in liquids. Separate abstracts are prepared for the two papers included. (WHK)

26047 (DSE/4017—1) **Summary of proceedings of solar heating and cooling commercialization workshop.** Bezdek, R.H.; Cambel, A.B.; Hauer, C.R. (George Washington Univ., Washington, D.C. (USA). School of Engineering and Applied Science). May 1977. Contract EG-77-C-01-4017. 48p. Dep. NTIS, PC A03/MF A01.

A summary of the Proceedings of the Solar Heating and Cooling Commercialization Workshop held on May 4 and 5, 1977 at the George Washington University is presented. The objective of the workshop was to examine the present "state of commercialization" of solar heating and cooling and to obtain suggestions from the various parties of interest on how the existing commercialization process might be improved. The discussions were limited to the existing government program and near term program changes which could increase the growth rate of solar energy heating and cooling. A four session workshop was conducted in which the following general areas were covered: (1) the industrial perspective; (2) legal issues; (3) the utility interface; and (4) institutional considerations. The complete set of proceedings were transcribed and may be obtained at cost in photocopy form from the Office of Energy Programs, George Washington University. (WHK)

26048 (EPRI-ER—594) **System definition study: Phase 1 of individual load center, solar heating and cooling residential project. Final report.** Burke, J.C.; Merriam, R.L.; Swanson, J.L. (Little (Arthur D.), Inc., Cambridge, Mass. (USA)). Dec 1977. 275p. Dep. NTIS, PC A12/MF A01.

A study was carried out to determine preferred systems for residential solar and load management heating, cooling and domestic hot water systems in the Northeast and Southwest regions of the United States. The program (1) developed a methodology for relating the performance of solar and load management heating and cooling systems to utility power generation, costs of supply and weather characteristics; (2) identified preferred systems in the service areas of two utilities—Long Island Lighting Company (LILCO) and Public Service Company of New Mexico (PNM); (3) developed preliminary designs for five experimental systems in both the LILCO and PNM service areas with the intent of maximizing the acquisition of experimental information on systems compatible with utility operations; and (4) developed instrumentation and test and evaluation plans for the experiments. The methodology provides a means of determining systems which, on a life-cycle cost basis, minimize the total cost of meeting the energy needs for a specific application—including investments in generating capacity at the power plant, fuel costs and investments at the point of use for energy conservation and HVAC equipment. The methodology was tested for 14 additional utilities throughout the United States.

26049 (LA—6807-PR, pp 34-48) **Solar energy research.** Balcomb, J.D. May 1977.

In Energy technology. Progress report, January—March 1977.

LASL's solar energy programs are funded by ERDA, Division of Solar Energy, and all fall within the category of direct thermal applications. Activities are described in the areas of solar collector research and technology, passive solar heating systems, Rankine-cycle chiller, mobile/modular home solar project, and agricultural and process heat applications. Also, technical assistance to the ERDA Division of Solar Energy in assessment of solar heating and cooling technology is described. (WHK)

26050 (LA-UR—77-186) **ERDA facilities solar design handbook.** Hunn, B.D. (Los Alamos Scientific Lab., N.Mex. (USA)). 1977. Contract W-7405-ENG-36. 181p. Dep. NTIS, PC A09/MF A01.

This handbook covers design of solar heating systems for commercial and laboratory buildings at Energy Research and Development Facilities. It includes discussions of solar energy fundamentals, solar heating and cooling technology, systems, and components, as well as a discussion of solar system economics. Quantitative analysis, with generalized design and sizing curves, is presented for solar heating so that collector and other system parameters can be cost-economically sized without a computer simulation. Solar system design considerations and guidelines, as well as guidelines for developing subsystem specifications, are presented. Thus this handbook is both a primer for the solar novice and a reference manual for the solar system designer.

26051 (LA-UR—78-131) **Impacts of the national energy programme on solar economics.** Ben-David, S.; Noll, S.; Roach, F.; Schulze, W. (Los Alamos Scientific Lab., N.Mex. (USA)). 1978. Contract W-7405-ENG-36. 70p. (CONF-780114—2). Dep. NTIS, PC A04/MF A01.

From International Solar Energy Congress; New Delhi, India (16 Jan 1978).

The National Energy Plan (NEP) sets as a goal the use of solar energy in two and a half million homes in 1985. A key provision of the NEP (as well as congressional alternatives) provides for the subsidization of solar equipment. The extent to which these subsidies (income tax credits) might offset the impact of continued energy-price control is examined. Regional prices and availability of conventional energy sources (oil, gas, and electricity) were compiled to obtain a current and consistent set of energy prices by state and energy type. These prices are converted into equivalent terms ($/10^6 Btu) that account for combustion and heat-generation efficiencies. Projections of conventional-fuel price increases (or decreases) are made under both the NEP scenario and a projected scenario where all wellhead price controls are removed on natural gas and crude oil production. The economic feasibility (life-cycle cost basis) of solar energy for residential space heating and domestic hot water is examined on a state-by-state basis. Solar-system costs are developed for each state by fraction of Btu heating load provided. The total number of homes, projected energy savings, and sensitivity to heating loads, alternative energy costs, and prices are included in the analysis.

26052 **Facts and figuring: sizing collectors for space heating.** Balcomb, J.D.; Hedstrom, J.C. (Los Alamos Scientific Lab., NM). *Sunworld;* No. 1, 25-27(Jul 1976).

A simplified method for determining the area of solar collector necessary to supply heat to a given building in a specified locale is presented. It is based upon computer analysis of weather data for 25 cities over a period of 12 yrs. Step-by-step calculation instructions are given. (RME)

26053 **Installation and maintenance of solar heating systems.** Kursh, S.J.; Anderson, W.M.; Costello, F.A.; Higgins, J.H.; O'Conner, J.K. Newark, DE; Univ. of Delaware (Mar 1976). 185p. (NP—22752).

This manual was prepared to aid the mechanical tradesman in acquiring a general knowledge of solar energy and its applications to domestic water heaters, swimming pool heaters, and space heating. The general configuration of solar energy systems is discussed. The language of solar energy and the basic principles of system design and performance are introduced. Each component of the solar energy system is analyzed. Alternatives in component construction and selection are presented and discussed with respect to their impact on system performance. The economics of solar energy systems are presented. Installation and maintenance of solar energy systems are considered. Both new construction and retrofit applications are discussed. The problems associated with specific systems installed at Solar One and elsewhere are discussed in detail. A summary of solar installations is presented. The energy situation and energy conservation techniques are included. The prospects for solar energy, new components and technologies, a brief summary of the market potential, and an economic analysis of a typical system are presented. (MHR)

AGRICULTURAL AND INDUSTRIAL PROCESS HEAT

REFER ALSO TO CITATION(S) 25982, 26049

WATER HEATING

REFER ALSO TO CITATION(S) 25985, 26039, 26042, 26043, 26044, 26046, 26048, 26050, 26051, 26053

26054 **Tap water heating with solar energy.** Dietrich, B. *HLH, Z. Heiz., Lueftung, Klim., Haustech.;* **28**: No. 9, 331-336(Sep 1977). (In German with English abstract).

The efforts for the utilization of solar energy on the field of technical building equipment have concentrated on the tap water heating. The author reports on the experiences as were collected at such plants, and describes the investigation results from a test plant which is being operated in the neighborhood of Essen, West Germany.

26055 Solar building panel concept for the supply of hot water. Spedding, P.L.; Allen, M.L.; Brow, D. (Univ of Auckland, NZ). *N.Z. Eng.;* **32**: No. 6, 126-131(15 Jun 1977).

A solar building panel concept is proposed which serves the dual function of acting as a solar collector as well as providing weather protection for a building. The panel is constructed from standard roofing material for incorporation in the roofing structure. Where the particular aspect of the building does not allow the incorporation of the solar building panel in the existing roof, the collector surface can be made up into a separate solar collector in the normal way. The solar building panel gave collection efficiencies close to 100% for low temperature differences of about 10°C.

26056 Swimming pool heating by solar energy. de Vasconcelos Martins, J.M.; de Lima, W.; Goldemberg, J. (Univ de Sao Paulo, Braz). *Rev. Bras. Tecnol.;* 7: No. 4, 407-413(Dec 1976). (In Portuguese).

A swimming pool is shown to be a good absorber of solar energy; however, the energy absorbed is dissipated to the environment. The varioius energy loss mechanisms in a swimming pool are discussed, and a method which makes it possible to partially avoid such losses is proposed. It is shown, theoretically and experimentally, that the temperature can be raised up to 3°C above that of the environment in summer. In swimming pools having conventional heating sytems, an appreciable fuel economy is possible using the system proposed.

OTHER

REFER ALSO TO CITATION(S) 25986

26057 Hot air motors for thermal conversion of solar energy. Godin, M.; Piar, G. (Univ de Dakar, Senegal). *Rev. Gen. Therm.;* **16**: No. 188-189, 609-625(Aug-Sep 1977). (In French with English abstract).

A review is made about the Stirling and Ericsson cycle hot air motors. The proposal is made regarding the classification of these motors based on the type of method used to make the pistons follow the movement for the required cycle: the motors with predetermined travel and free piston motors. Particular emphasis in applications of these motors is placed upon the conversion of solar energy into mechanical energy as well as to devices for artificial heart systems. 42 refs.

26058 Solar dryingin thin layers. Bhattacharyya, T.K.; Mazumdar, S.K. (Cent Mech Eng Res Inst, Durgapur, India). *Mech. Eng. Bull.;* 7: No. 3, 89-94(Sep 1976).

Solar drying in thin layers in two cabinet-type dryers and an open sundryer is compared to find their relative merits and demerits. A cabinet-type dryer with sloped transparent cover in front, a perforated cabinet dryer underneath a flat collector, and an open-tray dryer are the three types tested. The results of experimental investigations suggest that a perforated cabinet-type dryer underneath a flat collector gives higher drying rate especially at low moisture content than the other two types.

SOLAR COLLECTORS AND CONCENTRATORS

REFER ALSO TO CITATION(S) 25983, 26000, 26035, 26038, 26049, 26058

26059 (ANL-K—3805-1) **Analysis of design changes necessary to adapt receiver to compound parabolic reflector. Final report.** Bingman, R. (General Electric Co., Philadelphia, Pa. (USA). Space Div.). 13 Sep 1977. Contract W-31-109-ENG-38. 72p. Dep. NTIS, PC A04/MF A01.

An optimization study for the coupling of General Electric's vacuum tube receivers to ANL's compound parabolic reflectors to produce an efficient, cost-effective collector concept capable of operating in the 200 to 400°F range is presented. The thermal analysis study is described, a working fluids survey and recommendations are discussed, and an evaluation of the vacuum tube coating is included. Prototype hardware for test verification is described. (WHK)

26060 (COO—2930-12) **Optimization of coatings for flat plate solar collectors, Phase II. Final report, 28 June 1976—27 June 1977.** Lin, R.J.H.; Zimmer, P.B. (Honeywell, Inc., Minneapolis, Minn. (USA). Systems and Research Center). Jul 1977. Contract EY-76-C-02-2930. 133p. Dep. NTIS, PC A07/MF A01.

Optical coatings that would enhance the economic feasibility of flat plate solar collectors were investigated. Etched and dipcoated antireflection (AR) coatings and selective absorbing plated and paint coatings that are low cost and optically efficient were investigated. The best coatings previously identified in Phase I of the coating program were further optimized. A selective paint coating has been developed with solar absorptance (α) of 0.92 and room temperature emittance (epsilon) of 0.10. It was made through the optimization of coating thickness, pigment volume concentration, and pigment particle size. The selective paint has also been successfully scaled up to a sample size of 1 ft x 1 ft. The coating cost (materials and fabrication) was estimated at about 5 cents/sq ft, a factor of 10 lower than the selective plated coatings investigated. Accelerated humidity and outdoor exposure tests have been conducted for black chrome, black-nickel and black iron coatings. The black chrome coating is most durable and its life was estimated to be greater than 30 years. The use of surface roughening to improve the optical properties of black chrome resulted in a sample with $\alpha = 0.95$ and epsilon (100°C) = 0.09. A method has been developed which reduced the cost of black chrome by about 30 percent. Dipped AR coatings on glass using low refractive index Teflon FEP resulted in a transmittance increase of about 4.9 percent over the 0.35 μm to 0.75 μm region. The feasibility of AR coating Tedlar by glow-discharge polymerization was investigated. Strength and durability of etched AR glass were tested. Studies on the chemistry of glass etching for better process control have also been initiated.

26061 (ERDA/NASA/1060—77/1) **Black chrome on commercially electroplated tin as a solar selective coating.** McDonald, G.E. (National Aeronautics and Space Administration, Cleveland, Ohio (USA). Lewis Research Center). 1977. Contract EX-76-A-29-1060-003. 12p. (CONF-770953—9; NASA-TM—73799). Dep. NTIS, PC A02/MF A01.

From Concentrating solar collector conference; Atlanta, GA, USA (26 Sep 1977).

The reflectance properties of black chrome electroplated on commercially electroplated tin were measured for various black chrome plating times for both the solar and infrared spectrum. The values of absorptance, α, and emittance, epsilon, were calculated from the measured reflectance values. The interdependent variations of α and epsilon were plotted. The results indicate that the optimum combination of the highest absorptance in the solar region and the lowest emittance in the infrared of the black chrome plated on commercially electroplated tin is obtained for a black chrome plating time of between one and two minutes.

26062 (SAND—77-1466C) **Laser ray trace and bi-directional reflectometry measurements of various solar concentrators.** Pettit, R.B.; Butler, B.L. (Sandia Labs., Albuquerque, N.Mex. (USA)). 1977. Contract EY-76-C-04-0789. 19p. (CONF-770953—4). Dep. NTIS, PC A02/MF A01.

From Concentrating solar collector conference; Atlanta, GA, USA (26 Sep 1977).

In order to characterize the optical quality of reflecting parabolic solar concentrators, two measurement techniques were developed. Laser ray trace measurements were used to determine the focal length and focused beam size of the parabolic structures, while bi-directional reflectometry was developed to measure the specular reflectance properties of mirror materials. The overall optical quality of a concentrator is calculated by combining results from these two measurements. Model parabolic structures were fabricated by commercial suppliers from a variety of materials, including forest products, metals, ceramics and plastics. Depending upon the materials and manufacturing process, average focal lengths were within +-4% of their design value, while slope errors ranged from approximately 1.5 mrad to approximately 8 mrad. Mirror materials studied included silvered glass, metallized plastic films and polished aluminum sheeting. For some mirrors, the specular beam profile was characterized by a normal distribution. Thus the reflectance properties are completely described by a reflectance and a standard deviation. However, for the remaining mirrors, the specular beam profile was characterized by the sum of two normal distributions. Measured solar reflectance values ranged from 0.83 to 0.96 while standard deviation values ranged from approximately 0.2 mrad to over 30 mrad.

26063 Ellipsometry in the study of selective radiation: absorbing surfaces. Lushiku, E.M.; O'Shea, K.R. (Univ. of Dar es Salaam, Tanzania). *Sol. Energy;* **19**: No. 3, 271-276(Oct 1977).

Ellipsometry is the study of surfaces by the analysis of the state of polarization of reflected light. It is an extremely sensitive technique yet can be quite inexpensive. A simple form of the apparatus is described and the method of determination of optical constants, n and k, discussed. The relevance of the method in the study of selective surfaces is considered and comparisons made between calculated spectral reflectivities and experimental observations for electro-deposited black nickel films on copper substrate. Good agreement is found for a number of different authors, leading to a clearer understanding of former empirical results.

26064 New chrome black selective absorbing surface. Driver, P.M.; Jones, R.W.; Riddiford, C.L.; Simpson, R.J. (New South Wales Inst. of Tech., Broadway, Australia). *Sol. Energy;* **19**: No. 3, 301-306(Oct 1977).

The quest for more efficient solar absorbers has resulted in the development of numerous coating techniques for the absorption panel itself. The Chrome-Black coating is an electroplated black-chrome coating on a copper substrate which combines the properties of high visible absorption (α), low infra-red emission (epsilon) and excellent temperature stability in both air and vacuum environments. Results obtained show that surfaces may be produced both with high α/epsilon ratios, for example α = 87 percent, epsilon = 3 percent and α/epsilon = 28 and with high absorption, for example α = 92 percent, epsilon = 8 percent and α/epsilon = 11. These results were obtained assuming an air-mass-2 spectral distribution and a 50°C black body weighting for absorption and emission, respectively. All samples are known to be stable to at least 300°C. This type of coating would be expected to have good anticorrosion properties and this has been confirmed by electro-chemical oxidation and reduction testing. A comparison is made between the topography of this coating and of sputtered metal surfaces.

26065 Method for evaluating the solar energy provided by a flat insolator. Gicquel, R. (Ec Nat Super des Min, Paris, Fr). *Int. Chem. Eng.;* **17**: No. 4, 575-582(Oct 1977).

A method is proposed for evaluating the solar energy provided by a flat insolator at any inclination and orientation on the basis of available meteorological data. The optimum inclination is shown to depend on the use to which the heat is to be put, and the overall efficiency of the collector is found to be strongly dependent on the temperature level at which the heat is to be delivered.

26066 Some chemical aspects of solar energy utilization. Mattox, D.M. (Sandia Lab, Albuquerque, NM). *J. Solid State Chem.;* **22**: No. 1, 31-39(Sep 1977).

For solar energy to have a significant impact on the energy economy of the United States, hundreds of square miles of solar collectors will have to be constructed. The chemistry of materials fabrication and stability will play an important role in the economics of collector fabrication and service life. A review is presented for some of the material aspects of the materials involved and the environments to which they are exposed. In many cases, few data are available on the applicability of materials to solar applications. 32 refs.

26067 Selective black for absorption of solar energy. Telkes, M. (to Ses, Inc.). US Patent 4,011,190. 8 Mar 1977. Filed date 24 Nov 1975. 6p.

Improved selective black particles for use in solar receivers are described. The improved selective blacks comprise small particles of a metal having a low emissivity which are coated with a thin layer of an optically dark material having high absorptivity and low reflectivity for solar wavelengths and which is transparent for higher wavelengths in the thermal range. The improved selective black particles can be applied, e.g., as a paint, to any surface suitable for a solar heat receiver.

26068 Focused solar collector analysis with axially varying input due to shadowing from adjacent collectors. Lee, D.O.; Schimmel, W.P. Jr. (Sandia Lab, Albuquerque, NM). *AIChE Symp. Ser.;* **73**: No. 164, 181-185(1977).

An analytical expression for the shadowing of a collector by adjacent units as a function of collector location, spacing and orientation is presented. Hourly variations of solar input are accounted for as are the seasonal effects of solar zenith angle. Using the shadowing expression, an axial temperature differential analysis is used to determine the output of a linear focused solar collector being shadowed by adjacent collectors. Outputs for a typical spacing configuration are prsented for a north-south oriented collector field. Calculations are based on fixed tilt east-west tracking systems.

26069 Optical properties of thin film refractory metals. Gurev, H.S. (Univ. of Arizona, Tucson). pp 32-38 of Optics in solar energy utilization II . Selvage, C. (ed.). Palos Verdes Estates, CA; Society of Photo-Optical Instrumentation Engineers (1977).

From 20. annual SPIE technical symposium; San Diego, CA, USA (24 Aug 1976).

See CONF-760832—P1.

Molybdenum thin films have been produced by chemical vapor deposition with an emittance (calculated at 500°C) which is at least as low as the emittance of the pure, bulk metal (0.069). Tungsten films deposited by CVD have an emittance of 0.045 as compared to 0.019 reported for the bulk metal. These experimental results indicate the potential usefulness of CVD Mo or W thin films as infrared reflectors in tandem layer, spectrally selective, solar absorber systems. In addition, a spectrally selective CVD thin film which consists of a mixture of Mo and MoO_3 phases has been deposited which has a solar absorptance of 0.74 and a calculated emittance at 500°C of 0.063.

26070 Wavelength-selective surfaces for solar energy utilization. Fan, J.C.C. (Massachusetts Inst. of Tech., Lexington). pp 39-46 of Optics in solar energy utilization II . Selvage, C. (ed.). Palos Verdes Estates, CA; Society of Photo-Optical Instrumentation Engineers (1977).

From 20. annual SPIE technical symposium; San Diego, CA, USA (24 Aug 1976).

See CONF-760832—P1.

Wavelength-selective surfaces for solar energy utilization can be divided into two classes: selective-black absorbers and transparent heat mirrors. Selective-black absorbers absorb solar radiation and have low infrared thermal emissivity; transparent heat mirrors transmit solar radiation and reflect thermal radiation. We have used rf sputtering to prepare both selective-black absorbers (Cr-black and MgO/Au on metal substrates) and transparent heat mirrors (TiO_2/Ag/TiO_2, Sn-doped In_2O_3, and Sn-doped In_2O_3 microgrids) with excellent wavelength-selective properties for solar energy applications such as solar heating, solar/thermal/electric conversion, and window insulation.

26071 Comparison of solar photothermal coatings. Baumeister, P. (Univ. of Rochester, New York). pp 47-61 of Optics in solar energy utilization II . Selvage, C. (ed.). Palos Verdes Estates, CA; Society of Photo-Optical Instrumentation Engineers (1977).

From 20. annual SPIE technical symposium; San Diego, CA, USA (24 Aug 1976).

See CONF-760832—P1.

Various types of coatings have been considered as selective surfaces for solar photothermal energy collectors. These include the semiconductor overcoating of a metal, the lossy cavity, the artificial dielectric, the graded profile medium and the infrared reflector. These coatings are briefly described. Estimates are made of the cost of producing them en masse via electroplating, chemical deposition, sputtering, or vacuum evaporation. 70 references.

26072 Improved black nickel coatings for flat plate solar collectors. Lin, J.H.; Peterson, R.E. (Honeywell, Inc., Minneapolis). pp 62-71 of Optics in solar energy utilization II . Selvage, C. (ed.). Palos Verdes Estates, CA; Society of Photo-Optical Instrumentation Engineers (1977).

From 20. annual SPIE technical symposium; San Diego, CA, USA (24 Aug 1976).

See CONF-760832—P1.

A new black nickel formula was developed which had a solar absorptance of 0.92 and an infrared emittance (at 100°C) of <0.10 after 14 days at 38°C (100°F) and 95 percent relative humidity. This compares to coatings prepared with a previous NASA formula which had their solar absorptance degraded from 0.90 to 0.72 after the same period of humidity exposure. The electroplating bath and conditions were changed to obtain the more stable coating configuration. The effect of bath composition, temperature, pH, and plating current density and time on the coating composition, optical properties and durability were investigated.

26073 Error analysis of solar collector performance data. Bowen, J.C.; Bradford, P. (AMTEK, Inc., Hatfield, PA). pp 74-79 of Optics in solar energy utilization II . Selvage, C. (ed.). Palos Verdes Estates, CA; Society of Photo-Optical Instrumentation Engineers (1977).

From 20. annual SPIE technical symposium; San Diego, CA, USA (24 Aug 1976).

See CONF-760832—P1.

The equation for the efficiency of a collector measured on an instantaneous basis according to the proposed ASHRAE Standard 93-P (Procedure for Performance Testing Solar Collectors) is discussed. It is stated that there are three main weaknesses in current instantaneous test procedures: (1) the sun's output does not stay steady for a long enough period on enough days in a great enough area of the country; (2) accurate pyranometers calibrated for all radiation levels and at all mount angles are not in reliable supply; and (3) too little is known about the time constants of collectors to define the test duration. Resulting errors are briefly discussed. (WHK)

26074 ASHRAE'S approach to solar collector test standards. Yellott, J.I. (Arizona State Univ., Tempe). pp 80-89 of Optics in solar energy utilization II . Selvage, C. (ed.). Palos Verdes Estates, CA; Society of Photo-Optical Instrumentation Engineers (1977).

From 20. annual SPIE technical symposium; San Diego, CA, USA (24 Aug 1976).

See CONF-760832—P1.

The American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE), working through a Task Force appointed from Technical Committee 6.7, Solar Energy Applications, has completed and is now ready to distribute Proposed Standard 93-P, "Method of Testing for Rating Solar Collectors Based on Thermal Performance". This document is based on an earlier draft prepared in 1974 by J. E. Hill and Tamami Kusuda of the National Bureau of Standards for the National Science Foundation which then was the Federal agency responsible for solar energy research. The Hill-Kusuda proposal was carefully reviewed by competent groups drawn from ASME, ASHRAE and the International Solar Energy Society (ISES) and a number of changes were made by the authors before their proposed test procedure was published in De-

cember 1974 as NBSIR 74-635. This proposal has already been used widely and specifications are being written requiring that it be followed in testing collectors that are being offered for sale to government agencies. However, NBSIR 74-635 is not an officially adopted standard and it will undoubtedly be superceded by ASHRAE Proposed Standard 93-P which is the subject of the following paper. 93-P, prepared by a group of specialists drawn from universities, government agencies, private testing laboratories, manufacturers and users, provides for outdoor testing under the sun and indoor testing using a solar simulator. It also covers methods of determining collector time constants and incident angle modifiers. It is equally appropriate for use with concentrating and with flat plate collectors. It is anticipated that the new Standard will be issued early next year, following the usual review procedure, bearing the identifying number 93-77 to designate that it is the 93rd ASHRAE Standard and that its year of adoption is 1977.

26075 Infrared television measurement of heliostat images. Gray, D. (Martin Marietta Corp., Denver). pp 95-101 of Optics in solar energy utilization II . Selvage, C. (ed.). Palos Verdes Estates, CA; Society of Photo-Optical Instrumentation Engineers (1977).

From 20. annual SPIE technical symposium; San Diego, CA, USA (24 Aug 1976).

See CONF-760832—P1.

The current development of large focusing heliostats to concentrate solar energy on a boiler or central receiver requires a method for measuring the overall efficiency/performance of the heliostat. A flat plate calorimeter, using the temperature rise in water at a measured flow rate, has been used to test a 22.3- square meter heliostat focused at a distance of 31 meters. These measurements represent the first test of a large area concentrating heliostats in this country. This type of testing also established the requirement for verifying the accuracy of the collected calorimeter data. One of the methods used to accomplish this verification is described. The subject method to be discussed is the use of an AGA Thermovision Model 665 for determination of temperature gradients and flux patterns on the water filled plates of the calorimeter both with and without solar beam impingement. The initial thermovision testing has established that the infrared television can be a potentially valuable tool in the assessment of flux patterns, measurement of losses within the central receivers, and eventually for determination of energy concentrations within a reflected solar beam.

26076 Line focus segmented mirror concentrator. Anderson, D.E.; Stickley, R.A. (Sheldahl, Inc., Northfield, MI). pp 121-127 of Optics in solar energy utilization II . Selvage, C. (ed.). Palos Verdes Estates, CA; Society of Photo-Optical Instrumentation Engineers (1977).

From 20. annual SPIE technical symposium; San Diego, CA, USA (24 Aug 1976).

See CONF-760832—P1.

A solar concentrator system is described which is based on the use of a long array of east-west mounted focusing reflectors. Each of the reflective segments projects a line image of the sun into the entrance aperture of a stationary receiver through which a working fluid flows. Typically, ten segments in parallel are initially aligned to focus on the same receiver aperture; the mean solar flux across the aperture can be on the order of forty times that falling on the mirrors. The mirrors are steered by linked rotation about their individual centers to track the sun in elevation. Simple logic is also incorporated to rotate the mirrors into a face-down position on lack of sun or lack of demand. This provides for protection during storms and at night, and for defocusing in case the system overheats. The system is simple, well suited to installation and maintenance operations, and offers the potential for high efficiency in the intermediate temperature range at a low life-cycle cost.

26077 Principles of fixed mirror solar concentrator. Russell, J.L. Jr. (General Atomic Co., San Diego, CA). pp 139-145 of Optics in solar energy utilization II . Selvage, C. (ed.). Palos Verdes Estates, CA; Society of Photo-Optical Instrumentation Engineers (1977).

From 20. annual SPIE technical symposium; San Diego, CA, USA (24 Aug 1976).

See CONF-760832—P1.

A new concept for a fixed-mirror solar concentrator is described. The fixed, stepped surface of the proposed cylindrical mirror is designed to produce a sharply focused line image regardless of the incident sun direction. This is in contrast with the severe off-axis aberration (hence, poor concentration factor) of a parabolic mirror for all sun directions other than on-axis. It is shown that (1) the heat absorber follows a circular path to remain in the focus as the sun moves, (2) the annual light losses from self-shadowing of the "stepped" structure of the mirror surface can amount to less than approximately 10 percent for appropriate mirror orientation, (3) by facing the mirror in a southerly direction (in the northern hemisphere), the winter deficit in sun input can be significantly compensated, and (4) practical concentration factors of around 50 can be achieved with a single stage of concentration, 80 with a second stage of concentration.

26078 Solar collectors using total internal reflections. Kapany, N.S. (Univ. of California, Santa Cruz). pp 146-154 of Optics in solar energy utilization II . Selvage, C. (ed.). Palos Verdes Estates, CA; Society of Photo-Optical Instrumentation Engineers (1977).

From 20. annual SPIE technical symposium; San Diego, CA, USA (24 Aug 1976).

See CONF-760832—P1.

Various configurations of solar collectors and components employing the phenomenon of total reflection are described. A double glazed window using "Optical Ribs" has been developed to yield high light transmission and ruggedness. Conical wedges are developed for use as energy concentrators as well as "Optical Valves". Dielectric compound concentrators with flat, parabolic, and elliptical reflecting surfaces are described with various applications.

HEAT STORAGE

REFER ALSO TO CITATION(S) 26046

26079 (COO/4511—2, pp 17p, Paper 1) **Stratified versus well-mixed sensible heat storage in a solar space heating application.** Sharp, M.K.; Loehrke, R.I. 1977.

In CSU/DOE solar energy research program. Monthly progress report, November 1977.

The potential benefits of thermal stratification in a solar space heating application were assessed by comparing the predicted performance of a system using stratified storage with that of the same system using well-mixed storage. A simplified computer model of the system was constructed to facilitate a study of the influence of component size and performance on the overall performance. The model for the stratified storage tank accounts for vertical conduction in the storage material and tank walls, heat loss to the environment and vertical mixing of the storage fluid due to destabilizing temperature gradients induced by external heat losses. Fluid entering the tank from the collector and from the load is introduced without mixing at the location where the difference between the tank temperature and the incoming fluid temperature is a minimum. The systems were compared using water as the storage fluid. Operation over a seven-day period was simulated using measured, hourly weather data as input. The benefit due to stratification as measured by the increase in the fraction of the total heating load supplied by solar energy ranged from about 5 to 15 percent. This advantage was most strongly influenced by changes in collector mass flow rate, collector efficiency and minimum temperature required by the load. Other parameters such as building heat loss and tank volume had a much smaller effect on the relative performance of the two systems. Vertical conduction through the storage fluid and tank walls was found to have only a small effect on the operation of the stratified tank in this application. The results of this study indicate that a significant improvement in system performance may be realized if thermal stratification can be maintained in the storage tank.

26080 (COO/4511—2, pp 43p, Paper 2) **Passive technique for enhancing thermal stratification in liquid storage tanks.** Loehrke, R.O.; Gari, H.N.; Sharp, M.K.; Haberstroh, R.D. 1977.

In CSU/DOE solar energy research program. Monthly progress report, November 1977.

Several passive techniques for introducing fluid into a storage tank containing a stratified liquid are described. One of these is explored in detail. It involves the use of a vertical, porous inlet manifold designed to remove the momentum of the incoming fluid and inhibit mixing while allowing buoyancy forces to position the fluid at the appropriate level in the tank. A theoretical analysis was performed to identify the key parameters which control the operation of this manifold. Scale model tests were performed with water as the working fluid to verify the predictions of the analysis. These tests, which were run in model Plexiglas storage tanks, combined detailed thermal measurements with flow visualization. A final series of experiments were conducted in a 600-gallon prototype storage tank. The volume of this steel tank and the flow rates and heating rates used in the experiments correspond roughly to those of a storage tank designed for a solar system with 300 square feet of collector surface sized for a diurnal storage cycle. Comparisons between the measured temperature profiles in the tank and those predicted for ideal, unmixed introduction of fluid indicate that nearly ideal stratification can be achieved when the inlet fluid temperature is fixed. Under variable inlet temperature conditions less than perfect stratification is generally realized. The theoretical work, however, points the way to improved performance under variable conditions.

GEOTHERMAL ENERGY

RESOURCE STATUS AND ASSESSMENT

26081 (NP—23047) **Report on the development of geothermal energy.** Haenel, R. (Niedersaechsisches Landesamt fuer Bodenforschung, Hannover (Germany, F.R.)). 28 Feb 1977. 5p. (In German). TIC.

The total geothermal energy of the earth within 5 km depth is equivalent to 100 million terawatt/yrs. One percent of that amount would meet the world energy demand for 4000 years. In 1977, only naturally occurring hot water and steam were being utilized for electricity generation. Natural warm water with temperatures of 50 to 150°C is used for domestic heating in the Federal Republic of Germany as well as other countries. In Hungary, thermal waters are used in greenhouses and agricultural soil to improve harvest yields. Approximately 7.5 GW of electricity were produced geothermally in 1975. Research is being carried out on improved methods of geophysical prospecting and on binary and ternary fluid systems. In the USA, hot dry rock systems are being researched at Los Alamos, New Mexico, particularly with respect to cost reduction in drilling and materials development. Other research is being conducted on increasing energy output through the addition of chemical reagents.

GEOLOGY, HYDROLOGY, AND GEOTHERMAL SYSTEMS

26082 (NP—23044) **Geothermal energy from salt domes.** Haenel, R. (Niedersaechsisches Landesamt fuer Bodenforschung, Hannover (Germany, F.R.)). 25 Mar 1977. 10p. (In German). TIC.

The amount of energy which can be extracted from a salt dome was calculated with the aid of simple models. Geological and geothermal data from the Benthe salt dome near Hanover (DE) were used for the numerical calculations. Five cavern shapes (upright cylinder, flat cylinder, cube, sphere and slot) were considered. It was assumed that all shapes were to equal surface area and that the temperature was constant at 25°C. The results are presented graphically. It was shown that in a first approximation the liberated energy is independent of the cavern morphology, with the exception of the slot, which yielded significantly less energy. The energy output drops within a year to about $^1/_{15}$ the initial value. After a period of 10 yrs the slot yields approximately 7.7 MWh/km^2. Calculations of the output of a flat cylindrical cavern outside the salt dome revealed that after the first 30 days the energy yield was identical to that of a similar cavern within the salt dome.

26083 **Transport phenomena in hydrothermal systems: the nature of porosity.** Norton, D.; Knapp, R. (Univ. of Arizona, Tucson). *Am. J. Sci.;* **277**: No. 8, 913-936(Oct 1977).

Porosity of rocks may be described by Phi/sub Total/ = Phi/sub Flow/ + Phi/sub Diffusion/ + Phi/sub Residual/. Laboratory experiments indicate that total porosities of fractured rocks in hydrothermal systems range from 0.2 to 0.01, and diffusion porosities range from 10^{-3} to 10^{-5}. Synthesis of data from the literature and field observations of fracture characteristics indicate that flow porosities range from 10^{-3} to 10^{-5}. Therefore, the major portion of total porosity in pluton environments is due to residual pores not interconnected to either flow or diffusion porosity. Permeability may be defined as a function of the abundance and geometry of continuous flow channels. Observations suggest that a planar fracture model is a reasonable first order approximation for fractures in pluton environments. An analysis of aperture, abundance, and continuity indicates permeabilities on the order of 10^{-14} cm^2 may characterize large regions of the crust. The proposed porosity model affords for the definition of the interface between circulating hydrothermal fluids and reactant minerals in a manner consistent with the physical phenomena and with the partial differential equations that describe advection-diffusion-reaction processes.

26084 **Transport phenomena in hydrothermal systems: cooling plutons.** Norton, D.; Knight, J. (Univ. of Arizona, Tucson). *Am. J. Sci.;* **277**: No. 8, 937-981(Oct 1977).

The nature of heat and mass transport in pluton environments has been described by partial differential equations and simulated by numerical approximations to these equations. A series of heuristic models computed on the basis of these equations describes the general features of fluid circulation in the vicinity of an intrusive igneous body within the upper 10 km of the Earth's crust. Analysis of these models indicates that fluid circulation is an inevitable consequence of the emplacement of magmas in the crust. The magnitude of this fluid circulation generates convective heat fluxes which predominate over conductive heat fluxes when host rock permeabilities exceed 10^{-14} cm^2. However, cooling rates for the pluton are not significantly shortened unless the pluton permeability is also $>10^{-14}$ cm^2. The geometries of fluid circulation and isotherms are directly affected by variations in pluton size, width, level of emplacement, and permeability, as well as the distribution of permeable zones in the host rocks. This analysis reveals the extent of fluid circulation, and magnitude of convective heat flux over broad crustal regions and along crustal plate boundaries where igneous activity is voluminous may be much greater than heretofore realized.

26085 **Calculation of two-phase flow and fracturing in a porous medium (abstract).** Davis, A.H.; Travis, B.J. (Los Alamos Scientific Lab., NM). *EOS, Trans., Am. Geophys. Union;* **58**: No. 6, 541(Jun 1977).

From AGU spring meeting; Washington, DC, USA (30 May 1977).

USA

REFER ALSO TO CITATION(S) 26094, 26097

26086 **Geology and chemistry of Hawaii geothermal project well-A, Kilauea Volcano (abstract).** Stone, C.; Fan, P.F. (Univ. of Hawaii, Honolulu). *EOS, Trans., Am. Geophys. Union;* **58**: No. 6, 540(Jun 1977).

From AGU spring meeting; Washington, DC, USA (30 May 1977).

NON-USA

26087 (NP—23046) **Temperature/depth distribution in the Federal Republic of Germany.** Haenel, R. (Niedersaechsisches Landesamt fuer Bodenforschung, Hannover (Germany, F.R.)). 25 Feb 1975. 12p. (In German). TIC.

Fourteen thousand oil drilling reports archived by the State Bureau of Soil Science of Lower Saxony (DE) were examined and approximately 1000 temperature measurements were found. Based on these data as well as recent values, a trend analysis was performed and a temperature map for 1000 m depth was drawn. The land area of the Federal Republic of Germany was then subdivided and the temperatures at depths of 500, 1000 and 2000 m were plotted as isotherms. Temperature anomalies were found in the Rhinegraben, the Stuttgart-Lake Constance area, and in northern Germany.

26088 **Comparative temperature measurements on Mount Etna lavas: problems and techniques.** Archambault, C.; Tanguy, J.C. (Univ., Paris). *J. Volcanol. Geotherm. Res.;* **1**: No. 2, 113-125(Sep 1976).

On the basis of investigations carried out since 1966 at Mount Etna, the temperatures of erupting magmas were determined within a few °C in the range 1000 to 1200°C, by using suitable techniques and apparatus. The best measurements are obtained from sheathed thermocouples that are briefly described. Particularly, a new continuously recording multithermocouple system was designed, tested satisfactorily, and compared with the performances of other pyrometers. Measurements should be made at lava vents or a few meters away and at least 30 to 50 cm into the flows, the highest values only being considered as significant. The magmatic temperatures and petrological characters appear closely related to the volcanic activity. In the normal state of moderate persistent activity of Mount Etna, the alkaline basic magma extrudes at a nearly constant temperature of 1080°C (corresponding to about 50% crystalline phases), meanwhile during stronger paroxysmal eruptions the magma temperature is higher (1125°C and possibly more) with a lower observed content of phenocrysts.

26089 **Identification of eruption clouds with the Landsat satellites.** Heinken, G. (Los Alamos Scientific Lab., NM); Pitts, D.E. *Bull. Volcanol.;* **32**: No. 2, 1-11(1975).

Landsat satellite images were selected for the analysis of a tephra-laden eruption cloud and a volcanic fume cloud. A 35 km long eruption plume from Sakurazima Volcano, Kyushu, Japan was viewed by the satellite on December 2, 1972. Multispectral Scanner (MSS) band 4 was density sliced into eight levels. Grey levels over the tephra-laden cumulus, which had formed at the terminus of the eruption plume, were distinct from most of the nearby cumulus clouds. MSS band 4 is the key band for identifying eruption clouds in overcast volcanic regions. A fume cloud from Stromboli, Italy was studied in the same manner. It is easily identified over land areas and for 8 km over water in areas of clear sky, but cannot be distinguished from banks of cumulus clouds.

26090 **Explanation of Joekulhlaups from Grimsvoetn, Vatnajoekull, Iceland.** Bjoernsson, H. (Univ. of Bristol, Eng.). *Joekull (Reykjavik);* **24**: 1-26(1974). (In English and Icelandic).

The cause and process of jokulhlaups from the subglacial lake Grimsvotn are explained. Possible future changes in the phenomenon are discussed. A topographical model of Skeidararjokull and the

Grimsvotn water basin, based on seismic, gravity and geodetic surveys is presented. Although the present knowledge of the subglacial topography is not detailed, the model is accurate enough to explain the jokulhlaup phenomenon. The glacier surface map, which is well known, proves to be of dominating importance. In a period of five or six years the water level in the lake rises about 100 m. The glacier is lifted off a subglacial ridge east of the lake and water is forced subglacially through a 50 km long route beneath Skeidararjokull, causing vast floods. When the water level has fallen about 100 m the waterway is sealed by rapid plastic deformation of the ice at the eastern edge of the Grimsvotn depression. The water level is not lowered to the subglacial rim. The mass and energy balances of the basin are discussed. A water basin of 300 km^2 collects water into a subglacial lake of about 30 to 40 km^3. About $^3/_4$ of this water has been melted by a subglacial geothermal area. The geothermal area is probably the most powerful one in Iceland and its extent is about the same as that of the Torfajokull area (energy flux 1.5 . 10^{17} J/yr, energy flux density 50 W/m^2, area 100 km^2). The flow of water estimated from the model agrees well with the estimated discharge of glacial rivers on Skeidararsandur. The primary cause of jokulhlaups from Grimsvotn is the melting of ice in the geothermal area. The slope of the glacier surface is altered and ice and water flow into the Grimsvotn depression. Two ways by which man could control the jokulhlaups process are discussed.

GEOTHERMAL EXPLORATION AND EXPLORATION TECHNOLOGY

REFER ALSO TO CITATION(S) 25729

26091 (NP—23043) **List of research and development of hot spring and geothermics.** (Geological Survey of Japan, Kawasaki, Kanagawa). 1977. 11p. (In Japanese). TIC.

The state of research and development of hot springs and geothermal fields in Japan is summarized. Fifty-four individual projects are reported. The information includes location, contractor, principal investigator, items studied, methods and results. Most of the studies entailed gravimetric, seismic, geochemical, electrical, gamma-ray, and spontaneous polarization studies as well as drill-core examinations.

GEOPHYSICAL TECHNIQUES AND SURVEYS

26092 Seismological methods and the search for geothermal resources. Butler, D.; Brown, P.L. (Micro Geophysics Corp., Golden, Colorado). pp 413-415 of Exploration frontiers of the central and southern Rockies. Veal, H.K. (ed.). Denver; Rocky Mountain Association of Geologists (1977).

From Symposium program RMAG fall field conference; Snowmass, CO, USA (29 Sep 1977).

See CONF-770972—.

Conventional refraction and reflection seismic methods have been applied to the discovery of earth heat in some instances, but unconventional methods derived from classical seismology have been more useful in geothermal exploration. Less well-known methods are emphasized herein, as refraction and reflection are well described elsewhere. The methods to be considered are the detection and location of discrete seismic events, usually called microearthquakes; the spatial mapping of continuous seismic emissions, often called the "dark spot" method; and the measurement of insitu rock properties, such as attenuation or velocity ratios. These methods of exploration presume a model of the target system, and a brief discussion of the model preceeds the description of each exploration tool. Finally the strategy for most effective use of these techniques is outlined.

26093 Evaluation of geophysical techniques for geothermal exploration on an active basaltic volcano (abstract). Furumoto, A.S. (Univ. of Hawaii, Honolulu). *EOS, Trans., Am. Geophys. Union;* **58**: No. 6, 540(Jun 1977).

From AGU spring meeting; Washington, DC, USA (30 May 1977).

26094 In situ thermal conductivity measurements for heat flow determinations in marine and lacustrine environments (abstract). Oldson, J. (Univ. of California, Berkeley); Wilde, P.; Welday, E.; Martin, R. *EOS, Trans., Am. Geophys. Union;* **58**: No. 6, 515(Jun 1977).

From AGU spring meeting; Washington, DC, USA (30 May 1977).

26095 Preliminary report of study on the gravimetric monitoring at the Takinoue geothermal area, Iwate Prefecture. Study on the geothermal system of geothermal area: the 4th report. Ogawa, K.; Suda, Y.; Hasegawa, I.; Baba, K. *Chishitsu Chosasho Geppo;* **28**: No. 4, 73-76(Apr 1977). (In Japanese).

Gravimetric data offer an important monitoring capability for mass removal in exploitation of the geothermal reservoir. An electric power station utilizing geothermal steam is now under construction at the Takinoue geothermal area, and 50 MW output is expected there. Gravity was measured at 25 points in 1974 to start monitoring. The observed data are shown. These are only the data of the initial stage and there is a plan to continue gravimetric measurement at the same points with precise leveling hereafter to detect the change of gravity with the production of geothermal steam.

26096 Temperature gradients within the adjacent to the North Island volcanic belt. Thompson, G.E.K. (DSIR, Wellington, New Zealand). *N.Z. J. Geol. Geophys.;* **20**: No. 1, 85-97(1977).

Temperature gradients were measured in 44 drillholes within the North Island volcanic belt, New Zealand, and in 4 further holes adjacent to this region. Temperature gradients ranged widely from zero, or slightly negative values to +815°C/km. This variation is attributed to the existence of convective hydrothermal systems within the volcanic belt. Heat flow values for five drillholes for which adequate litholigic data were available ranged from 28 to 113 mW/m^2.

26097 Use of geothermometer models in the exploration for a hydrogeothermal resource. Pearl, R.H. (Colorado Geological Survey, Denver). pp 417-421 of Exploration frontiers of the central and southern Rockies. Veal, H.K. (ed.). Denver; Rocky Mountain Association of Geologists (1977).

From Symposium program RMAG fall field conference; Snowmass, CO, USA (29 Sep 1977).

See CONF-770972—.

Geothermal energy, the heat of the earth, can be used for such diverse purposes as: generation of electricity, space heating, processing of agricultural products and recreation. Temperatures of the thermal fluids needed for these purposes should range upward from 40°C to well over 200°C. Geothermal exploration programs should contain most of the same methods employed for finding other natural resource deposits with the addition of geochemical methods. One of the more useful geochemical methods is based on the chemical composition of the thermal waters of a region. Using ratios of the concentration of selected ions in thermal waters an estimate of the subsurface reservoir temperatures can be made. When the geological conditions of Colorado are appraised in relation to the geothermal resources, it is noted that almost all of the mountainous area west of the Front Range and east of the Uncompahgre and Colorado Plateaus have the necessary conditions. This area can further be examined through the use of hydrogeological conditions and geochemical composition of the thermal waters. When so done it is noted several hot springs appear to have estimated reservoir temperatures sufficiently hot enough that they could be used to generate electricity. Further exploration should be done in the vicinity of these thermal springs to fully delineate the size and extent of the reservoir.

26098 Possible field variant for determining the earth heat flow by the method of temperature waves reduction (TWR). Zavgorodnya, O.V.; Gordienko, V.V. *Dopov. Akad. Nauk Ukr. RSR, Ser. B;* No. 6, 493-497(Jun 1976). (In Ukrainian).

A possibility is shown to determine the Earth heat flow by the TWR method on the basis of relatively short-time observations (3-4 months) at a depth of 5-10 m, which makes the field variant of this method real.

26099 Heat flow in a geothermally active area: the Geysers, California. Jamieson, I.M. Riverside, CA; Univ. of California (1976). 176p. University Microfilms Order No. 77-27,151.

Thesis (Ph. D.).

The Geysers steam field in northern California is well established with almost two hundred geothermal wells in an area of approximately sixteen square miles and an installed generating capacity of 522 megawatts. A study of temperature gradients, topographic effects, reservoir characteristics and their correlation was made in a portion of this area using data from shallow (500' +-) temperature gradient holes and from several suspended or abandoned wells. In examining temperature gradients it was necessary to take into account the effects of topography and thermal conductivity and to consider convective heat flow. Topographic effect was estimated by means of an electrical analog model, thermal conductivity values were found from core samples and conductive transfer was examined using a novel correlation between penetration rates and minor variations in temperature gradients. Analysis of the temperature gradients corrected for topographic effect indicates that gradients are extremely high over the known reservoir and that heat transfer from the reservoir to the surface is primarily by conduction. In close proximity to production, gradients corrected for topographic effect are much lower. This suggests a reservoir controlled by high angle fractures, a hypothesis which is in accord with data from drilling records in the area.The lower temperature gradients outside the

producing area are still above average (3.0+-°C/100') when corrected for terrain. In conjunction with the available gravity and geologic information this suggests hot intrusive material at depth over a wide area, with regional heat flow from this source to the surface primarily by conduction. The extremely high temperature gradients noted in the producing area reflect convective transfer of heat from depth by local steam and hot water systems.

GEOCHEMICAL TECHNIQUES AND SURVEYS

REFER ALSO TO CITATION(S) 26086

26100 Geochemistry of the Hawaii geothermal well, HGP-A (abstract). Kroopnick, P.M.; Buddemeier, R.W.; Thomas, D.; Lau, L.S.; Bills, D.; Siegel, S.; Siegel, B. (Univ. of Hawaii, Honolulu). *EOS, Trans., Am. Geophys. Union;* **58**: No. 6, 540(Jun 1977).

From AGU spring meeting; Washington, DC, USA (30 May 1977).

26101 Attempted geothermometric determination of maxima subsurface water temperatures of main hydrothermic areas of Languedoc—Roussillon and Pyrenees-Orientales. Avias, J.; Passavy, J.; Valat, J.L. (Universite des Sciences et Techniques du Languedoc, Montpellier, France). *C. R. Hebd. Seances Acad. Sci., Ser. D;* **284**: No. 12, 1025-1027(21 Mar 1977). (In French).

A general survey of thermomineral springs of Languedoc-Roussillon, brought out six main areas of geothermic positive anomalies. Maxima subsurface water temperatures are calculated using two geochemical indicators of subsurface temperature (SiO_2 content and Fournier and Truesdeil Na-K-Ca formula). Results and validity limits of these two indicators are discussed.

26102 Chemical components of hot springs in Nagano Prefecture. Noguchi, K. (Toho Univ., Japan). *Onsen Kagaku;* **27**: No. 2/3, 74-84(Dec 1976). (In Japanese).

In Nagano Prefecture many hot springs are found. Among them, the Yamanouchi Hot Springs Group containing Yutanaka, Andai, Shibu, Jigokudani and Kakuma Hot Springs is the greatest in quantity of thermal water. One of the thermal wells of Yutanaka emits hot water by steam pressure as high as 30 m. Kamisuwa Hot Springs Group is second in the amount of thermal water. The temperature of the thermal water of Daini-Seikosha in Suwa City (94.5°C) is the highest in this area. The highest content of chemical components of hot spring waters in Nagano Prefecture are as follows: Kasugayuzawa, Tazawa, and Kutsukake showed 9.0 in pH respectively. While the lowest values, Shichimi and Kaminoyu showed 2.8 and 3.0 in pH respectively. Kaminoyu showed 1256 mg/l in SO_4; Kagai No. 2 in Matsushiro 4430 mg/l Cl and Yamada 2440 mg/l Cl; Kumanoyu 205 mg/l H_2S and Yunomata 67 mg/l H_2S; Matsushiroso in Matsushiro 637 mg/l HBO_2 and Yamada 199 mg/l HBO_2; Yamada 1.62 mg/l As and Kakuma 1.46 mg/l As. The well waters of Shimokaneko Village in the neighborhood of Suwa Lake were found to be rich in fluoride and showed 6.75 mg/l F as the highest. All the boys and girls who have drunk the well water of this village for a long time were found to be suffering from mottled teeth.

26103 Iotopic evidence for local derivation of strontium in deep-seated, fracture-filling calcite from granitic rocks in drill hole GT-2, Los Alamos Scientific Laboratory Dry Hot Rock Program. Brookins, D.G.; Laughlin, A.W. (Univ. of New Mexico, Albuquerque). *J. Volcanol. Geotherm. Res.;* **1**: No. 2, 193-196(Sep 1976).

Fracture-filling calcites from GT-2 Drill Core (LASL-DHR Program) yield $^{87}Sr/^{86}Sr$ ranging from 0.724 to 0.734. These data indicate derivation of Sr in the calcite from 1.7 +- 0.1 b.y. old granitic basement rocks at depth and not from the overlying Madera Formation (Pennsylvanian) which possesses high Sr content with $^{87}Sr/^{86}Sr$ near 0.709. This, in turn, indicates that meteoric waters did not transport significant amounts of Sr from the Madera Formation into the Precambrian basement rocks to great depth.

26104 Tables of chemical analysis of mineral waters (1961—1966) from the Hot Spring Research Institute of Kanagawa Prefecture. Tajima, Y.; Hirano, T. *Bull. Hot Spring Res. Inst., Kanagawa Prefect.;* No. 3, 1-55(Nov 1966). (In Japanese).

One hundred and fifty mineral waters analysed from 1961 to 1966 are tabulated together with locality maps. Most of the specimens were collected from bore holes (300 to 700 m) in the Hakone and Yugawara districts.

EXPLORATORY DRILLING AND WELL LOGGING

REFER ALSO TO CITATION(S) 26085, 26086, 26100, 26103

GEOTHERMAL ENGINEERING

DRILLING TECHNOLOGY AND WELL HARDWARE

26105 Multiple-completion geothermal energy production systems. Van Huisen, A.T. US Patent 4,054,176. 18 Oct 1977. Filed date 31 May 1974. 10p.

A system for the mining of geothermal energy is described in which a plurality of geothermal wells radiate from a single surface site into a subsurface geothermal reservoir. The wells can be drilled by conventional slant drilling techniques and each may contain a closed end heat exchanger which receives water and generates steam. Some of the heat exchangers are disposed vertically and others are implanted horizontally. By alternating production of the wells in a programmed cyclical manner, convective movement of the hydrothermal fluid will occur within the geothermal zone. The generated steam is collected in a reservoir at the surface site and utilized to generate electricity. The condensate from the turbine can be recycled to the wells.

RESERVOIR STIMULATION AND EXTRACTION TECHNOLOGY

26106 (PB—271411) **Heat extraction from hot, dry rock masses. Progress report, 1 August 1976—31 January 1977.** Weertman, J.; Achenbach, J.D.; Bazant, Z.P.; Dundurs, J.; Keer, L.M. (Northwestern Univ., Evanston, Ill. (USA). Technological Inst.). Mar 1977. 82p.

In analytical studies of three dimensional crack growth and shape, crack orientation was studied and the condition of a circular crack has been relaxed; a method is under study to determine the crack shape when the pressure of fluid in the crack is prescribed. The growth and stability of parallel, thermally induced edge cracks was investigated as a function of a thermal wave progressing from a free surface, both analytically and by finite element numerical techniques. The geometrical theory of diffraction in three-dimensional elastodynamics was applied to the problem of diffraction by a large crack of a signal emanating from a point source. Fluid flow paths were calculated for flow within two dimensional elliptical cracks with line source near one end and a line sink near the other end.

GEOTHERMAL DATA AND THEORY

REFER ALSO TO CITATION(S) 27009

26107 Heat field of petroliferous regions of Ciscaucasia. Matvienko, V.N.; Sergienko, S.I. *Int. Geol. Rev.;* **19**: No. 8, 987-992(Aug 1977).

Translated from Izv. Akad. Nauk SSSR, Ser. Geol.; No. 2, 149-155(1976).

Heat-flow values at 34 new sites were calculated on the basis of heat-conductivity data for the territory of Ciscaucasia. By adding previous data, the total number of heat-flow determinations is 150, and the overall spread of its values is from 0.65 to 3.38 μ cal/cm^2/sec. Principal features of heat-flow distribution in Ciscaucasia result from a clear association between the geothermal parameters and the geologic-tectonic structure of the region. The overall pattern in heat-flow distribution is the universal distortion of the heat field by anticlinal structures associated with oil and gas fields. The values for heat generation in the crust and the subcrustal layers of the principal tectonic structures of Ciscaucasia were assessed on the basis of content of radioactive elements. Intense subcrustal heat sources are not required for the formation of hydrocarbons in the crust and their subsequent transformation. Moreover, crustal energy for achieving these processes is completely adequate, such as, for instance, occurs in the marginal foredeeps.

26108 Flow of heat from the Earth's interior. *Sci. Am.;* 60-67(Aug 1977).

A global heat-flow map was drawn on the basis of thousands of individual field measurements on continents and ocean floors. The heat-flow pattern is interpreted in terms of plate tectonics. The main zone of high heat flow is in the eastern Pacific Ocean off Central America and South America. This zone coincides with the East Pacific Rise, a major oceanic ridge where new sea floor is being extruded and carried away quite rapidly to yield a comparatively broad band of high heat loss. The oceanic ridges in the Atlantic Ocean and the Indian Ocean are spreading more slowly and hence result in a narrower zone of above-average heat flow. Other regions of fairly high heat flow include the marginal ocean basins of the western Pacific, which overlie active subduction zones, the western cordillera of North America, where subduction ceases between five and 10 million years ago, and Alpine Europe. The principal regions with below-average heat flow include all the ancient Precambrian shield and platform areas of the continents and the oldest parts of the ocean floor. (JGB)

26109 Comparison and interpretation of borehole and marine heatflow data from the Mediterranean and Aegean Seas (abstract). Erickson, A.J. (Univ. of Georgia, Athens). *EOS, Trans., Am. Geophys. Union;* **58**: No. 6, 515(Jun 1977).
From AGU spring meeting; Washington, DC, USA (30 May 1977).

26110 Non-linear least-square fitting approach for determining activation energies for high temperature creep (abstract). Parrish, D.K.; Gangi, A.F. (Texas A and M Univ., College Station). *EOS, Trans., Am. Geophys. Union;* **58**: No. 6, 514(Jun 1977).
From AGU spring meeting; Washington, DC, USA (30 May 1977).

26111 Temperature gradient of the upper mantle determined by the inversion of seismic data (abstract). Anderson, O.L.; Wilson, W. (Univ. of California, Los Angeles). *EOS, Trans., Am. Geophys. Union;* **58**: No. 6, 504(Jun 1977).
From AGU spring meeting; Washington, DC, USA (30 May 1977).

26112 Correlation of heat flow and crustal structure in Europe (abstract). Cermak, V. (Geophysical Inst., Prague); Smithson, S.B. *EOS, Trans., Am. Geophys. Union;* **58**: No. 6, 515(Jun 1977).
From AGU spring meeting; Washington, DC, USA (30 May 1977).

26113 Radiogenic heat flow from the upper mantle of continental regions. Gordienko, V.V. *Dopov. Akad. Nauk Ukr. RSR, Ser. B;* No. 6, 487-490(Jun 1976). (In Ukrainian).
On the basis of the data on pyrolytic composition of the upper mantle, ideas on existence within its limits of partially melted layer, asthenosphere, and on periodic action of a certain convective mechanism the conductive flow from the upper mantle is determined. Its magnitude proved to be related to the depth of asthenosphere and the age of the last tectonic activation of the region. The depth temperatures of the inactivated continental upper mantle are estimated.

PROPERTIES OF AQUEOUS SOLUTIONS

26114 (LBL—5931) **Viscosity of aqueous sodium chloride solutions from 0 to 150°C.** Ozbek, H.; Fair, J.A.; Phillips, S.L. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Dec 1977. Contract W-7405-ENG-48. 65p. (CONF-771112—3). Dep. NTIS, PC A04/MF A01.
From 29. annual southeastern regional meeting of the American Chemical Society; Tampa, FL, USA (9 Nov 1977).
A critical evaluation of data on the viscosity of aqueous sodium chloride solutions is presented. The literature was screened through October 1977, and a data bank of evaluated data was established. Viscosity values were converted when necessary to units of °C, centipoise and molal concentration. The data were correlated with the aid of an empirical equation to facilitate interpolation and computer calculations. The result of the evaluation includes a table containing smoothed values for the viscosity of NaCl solutions to 150°C.

26115 Concentration dependence of activation free energies in electrolyte diffusion (abstract). Graf, D.L.; Anderson, D.E. (Univ. of Illinois, Urbana). *EOS, Trans., Am. Geophys. Union;* **58**: No. 6, 539(Jun 1977).
From AGU spring meeting; Washington, DC, USA (30 May 1977).

26116 Vapor pressure of water at its triple point: highly accurate value. Guildner, L.A.; Johnson, D.P.; Jones, F.E. (National Bureau of Standards, Washington, DC). *Science;* **191**: No. 4233, 1261(26 Mar 1976).
The vapor pressure of water at its triple point was measured with greatly increased accuracy. The triple point was realized with newly designed equipment that enhanced the stability of the pressure and permitted any air released from solution to be removed by pumping. A diaphragm pressure transducer separated the water vapor from the helium used to transmit the pressure to the manometer. The pressure was measured with the National Bureau of Standards precision mercury manometer. The vapor pressure at the triple point was found to be 611.657 pascals with random uncertainties at the 99 percent confidence level of +-0.010 pascal. The systematic errors are estimated to be relatively insignificant.

PROPERTIES OF MINERALS AND ROCKS

REFER ALSO TO CITATION(S) 26083

26117 Cooling rate and geothermal potential of silicic plutons: effect of size, shape, depth, and thermal parameters (abstract). Nitsan, U.; McGetchin, T.R. (Los Alamos Scientific Lab., NM). *EOS, Trans., Am. Geophys. Union;* **58**: No. 6, 542(Jun 1977).
From AGU spring meeting; Washington, DC, USA (30 May 1977).

26118 Internally consistent thermodynamic data (abstract). Day, H.W. (Univ. of California, Davis); Kumin, H. *EOS, Trans., Am. Geophys. Union;* **58**: No. 6, 530(Jun 1977).
From AGU spring meeting; Washington, DC, USA (30 May 1977).

26119 Laboratory investigations of permeability loss in sedimentary rocks (abstract). Dengler, L.A.; Bonner, B.P.; Netherton, R.; Piwinskii, A.J.; Trimmer, D.A. (Univ. of California, Livermore). *EOS, Trans., Am. Geophys. Union;* **58**: No. 6, 539(Jun 1977).
From AGU spring meeting; Washington, DC, USA (30 May 1977).

ROCK-WATER-GAS INTERACTIONS

REFER ALSO TO CITATION(S) 26084

26120 Ore transport and deposition in the Red Sea geothermal system: a geochemical model. Shanks, W.C. III (Univ. of Southern California, Los Angeles); Bischoff, J.L. *Geochim. Cosmochim. Acta;* **41**: No. 10, 1507-1519(Oct 1977).
Thermodynamic calculation of distribution of dissolved aqueous species in the Red Sea geothermal brine provides a model of ore transport and deposition in good agreement with observed accumulations of base metal sulfides, anhydrite, and barite. The Red Sea brine is recirculated seawater that acquires high salinity by low-temperature interaction with Miocene evaporites and is subsequently heated to temperatures in excess of 200°C by interaction with recent rift zone intrusive rocks. At temperatures up to 250°C, $NaSO_4^-$ and $MgSO_4^0$ are the dominant sulfur-bearing species. H_2S forms by inorganic sulfate reduction at the higher temperatures but is maintained at a uniform concentration of about 2 ppM by the strength of the sulfate complexes. Chloride complexes solubilize metals at the higher temperatures, and thus sulfide and metals are carried together into the Atlantis II Deep. Below 150°C, the brine becomes supersaturated with respect to chalcopyrite, sphalerite, galena, and iron monosulfide due to chloride-complex dissociation. Sulfide precipitation rates, based on the rate of brine influx, are in good agreement with measured sedimentation rates. Anhydrite precipitates as crystalline fissure infillings from high-temperature inflowing brine. Barite forms from partial oxidation of sulfides at the interface between the lower hot brine and the transitional brine layer.

26121 Reaction of granodiorite with water at 300°C and 1/3 kb in a circulation system (abstract). Charles, R.W.; Vidale, R.J. (Los Alamos Scientific Lab., NM). *EOS, Trans., Am. Geophys. Union;* **58**: No. 6, 539(Jun 1977).
From AGU spring meeting; Washington, DC, USA (30 May 1977).

26122 Experiments of syntheses of carbonate minerals by thermal diffusion in porous media. Costeseque, P.; Schott, J. (Universite Paul-Sabatier, Toulouse, France). *C. R. Hebd. Seances Acad. Sci., Ser. D;* **284**: No. 12, 1005-1008(21 Mar 1977). (In French).
Experiments are reported on a possible mechanism of ionic transport by means of thermal diffusion in fluids within the lithosphere. The crystallisation of stable minerals induced by thermal diffusion, either directly by sursaturation or by metasomatose on a preexisting mineral, is described.

26123 Incrustations and fumarolic condensates at Kilauea volcano, Hawaii: field, drill-hole and laboratory observations. Naughton, J.J. (Univ. of Hawaii, Honolulu); Greenberg, V.A.; Goguel, R. *J. Volcanol. Geotherm. Res.;* **1**: No. 2, 149-165(Sep 1976).
Hawaiian volcanoes characteristically have but few of the many types of minerals found in incrustations of other volcanic areas. In Hawaii sulfates resulting from air oxidation of volatiles predominate, and fluorides produced during rock alteration by fumarolic gases are prominent. Halides are generally found where reducing conditions exist in fumaroles and lava lake drill holes. The most common mineral types are sulfur, opaline silica, gypsum, ralstonite, and thenardite. Minerals from the same deposit are found to vary markedly in the content of the less abundant components. Condensates from vapor issuing from fumaroles show little quantitative relationship in component content to incrustations deposited at the same fumaroles. It is believed that an energetically favorable isomorphic substitution of some elements in the crystal lattice of a depositing mineral may lead to the build-up of a high concentration

of an element from a lean vapor. Equilibrium calculations applied to condensate studies give a good quantitative approximation to the concentrations of the elements found in natural systems, but when applied to incrustations they serve only to indicate general compositional relations. Laboratory studies have shown the important role of chlorides in metal transfer in the gas phase in high-temperature aqueous systems, but only in the absence of oxygen. These studies also demonstrated the important role of HF in rock alteration and in the transfer of silica.

TIDAL POWER

26124 **Marine engineering--the canadian challenge.** Reid, I. *Eng. J. (Montreal);* **60**: No. 4, 6-11(Jul-Aug 1977).

Changes in marine research and applications expected to take place with the proclamation of a 200-mile coastal zone are discussed. Buoy design and construction, tidal energy utilization, heliports for offshore lighthouses, and construction of sand islands in deep water, are considered.

WIND ENERGY

AVAILABILITY (CLIMATOLOGY)

REFER ALSO TO CITATION(S) 26125

ECONOMICS

REFER ALSO TO CITATION(S) 26125

WIND ENERGY ENGINEERING

26125 **Wind power for india.** Tewari, S.K. (Natl Aeronaut Lab, Bangalore, India). *Sunworld;* No. 4, 7-9([nd]).

Measurements of actual wind speeds and their duration have been made for many years at meteorological stations scattered over the country, representative values being given in table. Of the 18 sites listed, only three have power densities less than 100 watts per square meter and two have power densities almost twice this value. At most of these sites, wind speeds at or above the design speed are available for 1000-1800 hours per year (out of 8760 hours in a year). Work is under way to find the optimum sites for locating large wind generators. The author stresses that windmills could provide both water and electricity for villagers.

TURBINE DESIGN AND OPERATION

26126 (ERDA/NASA/1028—77/12) **Approximate method for calculating free vibrations of a large-wind-turbine tower structure.** Das, S.C.; Linscott, B.S. (National Aeronautics and Space Administration, Cleveland, Ohio (USA). Lewis Research Center). Dec 1977. Contract EX-76-A-29-1028. 42p. (NASA-TM—73754). Dep. NTIS, PC A03/MF A01.

A set of ordinary differential equations are derived for a simplified structural dynamic lumped-mass model of a typical large-wind-turbine tower structure. Dunkerley's equation is used to arrive at a solution for the fundamental natural frequencies of the tower in bending and torsion. The ERDA-NASA 100-kW wind turbine tower structure is modeled, and the fundamental frequencies are determined by the simplified method described. The approximate fundamental natural frequencies for the tower agree within 18 percent with test data and predictions analyzed by means of NASTRAN.

26127 **Windpower.** Melaragno, M. (Univ of NC, Charlotte). *Engineering (London);* **217**: No. 1, 38-39(Jan 1977).

The author briefly reviews the history of the utilization of wind power and the theoretical calculations of the power extractable from the wind, allowing for the fact that a certain amount of kinetic energy (about 40%) must remain in air so that it can continue to flow downstream, allowing the upstream air to advance. In this latter connection, the power absorbed by a wind-turbine of a given diameter can be increased by enlarging the volume of air that passes through. Placing the turbine in an open duct of larger diameter increases the diameter of the column of air passing through A gradual reduction of the duct downstream of the turbine increases the velocity of the air in this zone allowing a higher percentage of energy to be extracted from the wind. A number of research studies have analyzed such methods. Technical and cost data are then given regarding recent NASA projects. One of these is a 100 kw experimental wind turbogenerator, and preliminary design-study data and cost estimates are given for a 500 kw and two 1500 kw high-power wind turbines. Cost estimates of the high-power units indicate that they should be comparable to conventionally produced energy in the United States.

ELECTRIC POWER ENGINEERING

REFER ALSO TO CITATION(S) 26521, 26524, 26526, 26533

POWER PLANTS AND POWER GENERATION

REFER ALSO TO CITATION(S) 26544

26128 **Reliability indices of power units following their enlargement.** Moiseeva, L.N. (Cent Boiler and Turbine Inst, USSR). *Energomashinostroenie;* No. 6, 6-7(1977). (In Russian).

Retrospective data on the operation and the effect of the enlargement of power units on their reliability indices are considered. Data about Soviet, West German and American power units are discussed. It is found that the fears often expressed that with the increase in unit capacity their reliability decreases are not supported by data about their operation if more advanced design of the equipment to be enlarged is adopted.

COOLING AND HEAT TRANSFER EQUIPMENT AND SYSTEMS

26129 (CONF-770151—9) **CTI water cooling tower thermal performance: testing procedures and instrumentation.** Doll, C.K. (Midwest Research Inst., Kansas City, Mo. (USA)). Jan 1977. 33p. Research Inst., Kansas City, MO.

From Meeting of the cooling tower institute; Houston, TX, USA (31 Jan 1977).

The Cooling Tower Institute (CTI) offers to the cooling tower industry and users an unbiased cooling tower performance testing and certification service. The service, how to obtain tests, procedures for conducting the tests, descriptions of instrumentation used, and problem areas to watch for that can cause errors in test results are discussed. Selected sections of the Cooling Tower Institute Acceptance Test Code 105 (ATC-105) dealing with collection and reduction of field data are presented. The test report is described, and the limited distribution of this report, because of its proprietary nature, is discussed.

26130 (GFERC/IC—77/1, pp 43-73) **Coal Creek Station steam generators.** Hickok, W.W. (Cooperative Power Association, Minneapolis); Taylor, D.A.; Dutton, R.W.; Keirstead, R.C. 1977.

From 9. biannual lignite symposium) technology and use of lignite; Grand Forks, ND, USA (18 May 1977).

In Technology and use of lignite.

The major systems in the Coal Creek complex are described, including water source, turbine-generator, cooling towers, circulating water, auxiliary cooling water, closed cooling water, 6.9 kV auxiliary electric, compressed air, corrosion protection, boiler feed pumps, feedwater, condensate, fuel oil, air pre-heating, generator cooling and purging, demineralizer, water pretreatment, chemical cleaning, fire protection and ash handling. The station consists of a two unit, 1000-MW, mine-mouth plant being constructed in central North Dakota, and is a joint project of the Cooperative Power Association and United Power Association; both are generation and transmission cooperatives. Lignite mining and handling, combustion systems, flue gas cleaning, and waste disposal are reviewed.

26131 (NTIS/PS—77/0804) **Cooling towers (citations from the NTIS data base). Report for 1964—August 1977.** Hundemann, A.S. (National Technical Information Service, Springfield, Va. (USA)). Sep 1977. 225p.

Abstracts of Federally-funded research dealing with design and environmental impacts of wet and dry cooling towers are presented. Cooling tower drift instrumentation and thermal and chemical pollution control systems are covered. Citations primarily pertain to cooling towers used in nuclear power plants, with a few pertaining to cooling towers used in wastewater treatment. (This updated bibliography contains 220 abstracts, 54 of which are new entries to the previous edition.)

26132 (NTIS/PS—77/0805) **Cooling towers: design and performance (citations from the Engineering Index Data Base). Report for 1970—August 1977.** Hundemann, A.S. (National Technical Information Service, Springfield, Va. (USA)). Sep 1977. 248p.

Abstracts from worldwide research on design and performance of mechanical draft and natural draft wet, dry, and dry-wet combination cooling towers are discussed. Citations cover studies on size reduction, corrosion protection, and economic optimization of cooling towers primarily used with nuclear power plants and fossil fuel power plants. A few abstracts pertain to cooling towers used in wastewater treatment. (This updated bibliography contains 241 abstracts, 120 of which are new entries to the previous edition.)

26133 (NTIS/PS—77/0806) **Cooling towers: environmental studies (citations from the Engineering Index Data Base). Report for 1970—August 1977.** Hundemann, A.S. (National Technical Information Service, Springfield, Va. (USA)). Sep 1977. 124p.

Abstracts from worldwide research on thermal, meteorological, and ecological effects associated with cooling towers used primarily by fossil fuel and nuclear power plants are cited. Citations cover plume behavior studies, including measurement of airborne particulate concentration, and characterization and management of drift as well as noise pollution and salt deposition effects on vegetation. A few abstracts pertain to environmental effects from cooling towers used in wastewater treatment. (This updated bibliography contains 117 abstracts, 47 of which are new entries to the previous edition.)

26134 Experimental investigations of buckling and stability determination of cooling tower shells. Mungan, I. *Tech. Mitt.;* **70**: No. 8, 499-504(Aug 1977). (In German).

Studies on hyperbolic rotational shell models show that buckling of these shells is locally initiated when a critical combination between membrane stresses in the meridian and circular direction occurs. The buckling safety of cooling towers under dead load and wind load may be assessed with the aid of a dimensionless interaction diagram which has been experimentally determined and theoretically explained.

26135 Risk analysis for natural-draught cooling towers under wind load. Niemann, H.J. *Tech. Mitt.;* **70**: No. 8, 509-512(Aug 1977). (In German).

A satisfactory safety level of natural-draught cooling towers is usually reached by assuming an extreme wind load, for which the probability of being exceeded is very low. Taking into account the dispersion of strength, the relevant extreme wind velocity for the limiting carrying capacity is calculated for a desired probability of failure. Compared with the method of partial safety coefficients, the reliability can be calculated more exactly in this way, even though the probability distribution of the extreme wind velocity must be extrapolated from limited observations.

26136 Possible cooling tower designs and their economy. Zerna, W. *Tech. Mitt.;* **70**: No. 8, 512-520(Aug 1977). (In German).

The supporting shells of natural-draught cooling towers make very high demands on calculation and construction. Of the possible constructions, reinforced-concrete cooling towers constructed with the aid of climbing forms are the only ones which appear to be functional and economical. THe choice of the meridian curve of the cooling tower shell, which may be a hyperboloid of revolution or, in a more recent construction, of bell shape, is of great importance. In very large cooling towers, bracing rings cannot be dispensed with, as they improve the buckling and vibrational behaviour of the shell. This type of construction is also more economical than cooling tower shell with continuously varying shell thickness.

26137 Influence of method of cooling tower operation on plume length. Gerking, E.; Hamann, H. *VGB Kraftwerkstech.;* **57**: No. 5, 326-333(May 1977). (In German).

By means of a simple procedure it is possible to estimate the length of cooling tower plumes with direct cooling operation compared with closed circuit operation. As a specific example it is demonstrated that direct cooling operation causes considerably shorter plumes than closed circuit operation.

26138 Application of statistical methods to obtain analytical characteristics of air condensing installations. Marukhyan, V.Z.; Kuloyan, L.T. (Yerevan Polytech Inst, Arm SSR). *Teploenergetika (Moscow);* No. 5, 73-75(May 1977). (In Russian).

The passive experiment method is used to determine the dependence between the cooling water temperature and the meteorological factors, with subsequent processing of test results by means of regression analysis. The air condensing installations of the Heller-Forgo system with a dry cooling tower at the Razdan district power plant served as the object of an investigation. Expressions are obtained permitting prediction of the temperature of the circulatory water at the cooler outlet. Mathematical expressions for the cooling tower and the condenser may be used to optimize the consumption of the cooling water in the circulatory water supply system.

26139 Supporting behaviour of natural-draft cooling towers under special consideration of mining influences. Kraetzig, W.B. (Bochum Univ. (Germany, F.R.)). *VGB Kraftwerkstech.;* **57**: No. 4, 287-290(Apr 1977). (In German).

Axially symmetrical cooling shells with their supports and foundation elements exhibit a very favorable supporting behavior with respect to mining influences, resisting them demage-free without or with little additional constructional effort. This paper primarily deals with cooling shells including their supports and foundations. Water supply and distribution, cascading system, and water basin are admittedly unseparable components of wet coolers, but their safety problems with respect to damage due to mining operations lie in the range of classical methods of solution.

26140 Experience of operation and results of tests of TP-100 and TP-100A boilers with open-loop pulverized fuel systems designed by tckti. Burgvits, G.A.; Luzin, P.M.; Semenyuk, V.M.; Polyakov, G.A.; Pavlyuk, V.F.; Korotov, E.I.; Gudzenko, V.S. (Cent Boiler and Turbine Inst, USSR). *Energomashinostroenie;* No. 7, 34-35(1977). (In Russian).

Results of the operation and tests of boilers with open-loop pulverized fuel systems designed by the Central Research and Project Design Boiler and Turbine institute (TsKTI) and installed at the Burshtyn district power station (West Ukraine) are presented. The 200 MW power units burn coal from the Lvov-Volynian deposit and some waste products of Donbas coal. The boilers were originally designed for closed systems of pulverized fuel preparation with drum and ball mills, intermediate bunkers, air drying and p.f. feeding into the burners by the spent drying agent. The changeover to the open-loop system has improved the general performance of the boiler even if coal with low and comparatively stable moisture content is used as fuel.

POWER CYCLES

REFER ALSO TO CITATION(S) 26189

26141 (FE—1806-20) **Development of high temperature turbine subsystem technology to a "technology readiness status": Phase I. Quarterly report, January—March 1977. Preliminary draft.** Caruvana, A. (General Electric Co., Schenectady, N.Y. (USA). Gas Turbine Div.). 24 Jun 1977. Contract EX-76-C-01-1806. 221p. Dep. NTIS, PC A10/MF A01.

Design and analysis details are described for the three combustor designs evaluated including the effects of a 3000°F firing temperature. It is concluded that only the sectoral combustor design has the potential for growth to the 3000°F firing temperature. A final design analysis report has been completed for the hot gas path test stand. The design conforms to appropriate sections of the ASME Boiler and Pressure Vessel Code. Facilities modifications to accept the stand when fabricated are described. Thermal and stress analyses of the nozzles and buckets of the TRV turbine are delineated. Design details of these items are included with data on water collection and distribution. The design efforts and evaluations pertinent to the hardware for the backup cooling schemes are described. Analyses include parts lives predictions based on rupture and low cycle fatigue requirements. Various fabrication methods of composite construction were investigated as was investment casting of the large complex shapes expected in the 3rd Stage nozzle. Included also are the results of fabricating monolithic 3rd Stage buckets. Materials properties data were obtained for representative materials relative to thermal coefficient of expansion, thermal conductivity, and low cycle fatigue. System analyses and arrangements for the combined cycle plants under study were updated. Significant changes are described plus the reevaluation of cleanup systems with attendant details. Failure mode and effects analyses are included with emphasis on the creation of a technique and format to provide a foundation for future efforts.

26142 (FE—2357-19) **CFCC Development Program. Monthly report, November 1977.** (General Electric Co., Schenectady, N.Y. (USA). Energy Systems Programs Dept.). Jan 1978. Contract EX-76-C-01-2357. 27p. Dep. NTIS, PC A03/MF A01.

System Engineering effort has been focused on two areas, in order to guide evolving technology investigations. The first, the interaction of alternate combustor steam generator configuration addresses the control and mechanical interface issues. The second, a study of conventional cyclone utilization, is being used to guide the advanced inertial separator development. Several combustor/steam generator concepts have been conceptualized including a shippable configuration (four vessels per gas turbine) and a modified tube geometry (involute) resulting in two vessels per turbine module. In the gas turbine materials area, over 1000 hours have been accumulated on the burner rig simulations and some of the baseline materials are showing initial signs of corrosion—hence, they have been removed and will undergo analysis. Materials for exposure in the PFB environment as part of the Fireside II 1000 hours test have been selected and specimen cladding has been initiated. Further analysis of the results of CURL Test No. 7 has led to the conclusion that a segregation of ash and sorbent in the efflux takes place as a function of particle size with ash concentrating in the fines.

26143 (FE—2371-20) **Evaluation of a pressurized-fluidized bed combustion (PFBC) combined cycle power plant conceptual design. Quarterly report, July 1—September 30, 1977.** Huber, D.A. (Burns and Roe Industrial Services Corp., Paramus, N.J. (USA)). Oct 1977. Contract EX-76-C-01-2371. 19p. Dep. NTIS, PC A02/MF A01.

Efforts were concentrated on firming up the conceptual design of a combined-cycle power plant containing four pressurized fluidized-bed combustors exhausting to two gas turbines followed by a steam-cooled atmospheric fluidized-bed boiler. The design of the PFBs, gas turbines, gas ducting and balance of the plant were completed in sufficient detail to initiate cost estimation activities. Plant instrumentation and control criteria were established and cost estimation initiated. An integrated plant start-up/shutdown procedure was developed and is being reviewed. Efforts continued on the development of an order-of-magnitude capital and operating cost estimate for a Spent Sorbent Regeneration System sized for a 600MWe PFB Power Plant. Preliminary results indicate that a once-through spent additive and ash disposal system without regeneration is the most attractive economically. Studies were initiated on reliability, maintainability and environmental analysis. Efforts are under way to develop a computer program which not only compares the thermodynamic performance of various cycles but gives a rapid estimate of the capital and operating costs.

26144 (FE/2664—3) **Ceramic technology readiness program. Third monthly technical progress report, November 28, 1977—January 1, 1978.** (AiResearch Mfg. Co. of Arizona, Phoenix (USA)). 16 Jan 1978. Contract EF-77-C-01-2664. 27p. Dep. NTIS, PC A03/MF A01.

The program objective is to (1) provide convincing evidence of the ability of ceramic components to survive for lifetimes adequate for utility applications in an environment of high temperature combustion products from coal-derived fuels and, (2) to develop and demonstrate technology readiness for the application of ceramic materials technology to advanced gas turbines operating on coal-derived fuels in utility base load and intermediate load service. Technical goals are to supplement and enhance development of ongoing high temperature (cooled component) turbine technology and understanding between material suppliers/processors, and turbine builders regarding materials capabilities, design methodology (emphasizing reliable means for predicting minimum time to first failure) and utility hardware requirements and (2) to ensure a supply of basic ceramic powders for use in non-commercial investigations of materials properties, fabrication techniques, and test methods.

26145 (MIT—2295-T18-3) **Combined cycle research program, January 1—March 31, 1977.** Louis, J.F.; Toppings, R. (Massachusetts Inst. of Tech., Cambridge (USA). Energy Lab.). Apr 1977. Contract EX-76-C-01-2295-018. 44p. Dep. NTIS, PC A03/MF A01.

Gas turbine-steam turbine combined cycle power plants, operating on coal or coal-derived fuels, are thought by many experts to be the most practical and efficient choice for next generation electric power production. The major benefits of this combined cycle system are the potential attainment, at relatively low risk and development cost, of high efficiencies while maintaining pollutant emissions within environmental specifications. The industrial gas turbine is not without its development problems, however. Research is needed in turbine cooling, turbine materials corrosion and fuel gas clean up. While separate disciplines in themselves, they all closely interrelate in determining allowable turbine operating temperature and overall cycle performance. MIT has been commissioned by the US Energy Research and Development Administration to undertake some essential work for the future development of combined cycle power plants. This three year research program deals with critical problems related to combined cycles; turbine cooling with air and water, materials corrosion and high temperature fuel gas desulfurization. Research in these areas will provide needed data for turbine component design and thus serve as a necessary compliment to the ERDA High Temperature Turbine Technology Program. The effort will also provide corrosion data for other metal and ceramic components and necessary information concerning high temperature desulfurization; as well as providing accurate experimental data for input into, and verification of, the various computer simulator models under development.

26146 (MIT—2295-T18-4) **Combined cycle research program. First annual report, July 1, 1976—June 30, 1977.** Louis, J.F. (Massachusetts Inst. of Tech., Cambridge (USA). Energy Lab.). Jul 1977. Contract EX-76-C-01-2295-018. 83p. Dep. NTIS, PC A05/MF A01.

Gas turbine-steam turbine combined cycle power plants, operating on coal or coal-derived fuels, are thought by many experts to be the most practical and efficient choice for next generation electric power production. The major benefits of this combined cycle system are the potential attainment, at relatively low risk and development cost, of high efficiencies while maintaining pollutant emissions within environmental specifications. The industrial gas turbine is not without its development problems, however. Research is needed in turbine cooling, turbine materials corrosion, and fuel gas clean-up. While separate disciplines in themselves, they all closely interrelate in determining allowable turbine operating temperature and overall cycle performance. A three-year research program has begun which deals with critical problems related to combined cycles: turbine cooling with air and water, materials corrosion, and high-temperature fuel gas desulfurization. Research in these areas will provide needed data for turbine component design and thus serve as a necessary complement to the ERDA High-Temperature Turbine Technology Program. The effort will also provide corrosion data for other metal and ceramic components and necessary information concerning high-temperature desulfurization, as well as providing accurate experimental data for input into, and verification of, the various computer simulator models under development.

26147 (NTIS/PS—77/0991) **Combined cycle power generation (citations from the NTIS data base). Report for 1964-Oct 77.** Hundemann, A.S. (National Technical Information Service, Springfield, Va. (USA)). Nov 1977. 74p. NTIS PC N01/MF N01.

Federally-funded research pertaining to design, efficiency, cost, resource requirements, and environmental aspects of combined cycle power plants is discussed. Abstracts primarily deal with use of coal gasification in conjunction with combined gas and steam turbine generation, including subsystems development studies. (Contains 69 abstracts)

26148 (NTIS/PS—77/0992) **Combined cycle power generation (citations from the Engineering Index data base). Report for 1970-Oct 77.** Hundemann, A.S. (National Technical Information Service, Springfield, Va. (USA)). Nov 1977. 122p. NTIS PC N01/MF N01.

Design, performance, efficiency, economics, and environmental aspects of combined cycle power plants are discussed. Abstracts of worldwide research cover the use of waste heat from gas turbines to drive steam turbines and the thermal efficiency of integrated gasification combined cycle plants using low or intermediate Btu gas. A few abstracts pertain to controls and instrumentation used in the plants. (Contains 115 abstracts)

26149 (TID—28200) **Closed gas turbine heater program. Second quarterly technical progress report, July 4, 1977—October 2, 1977.** Stefun, R.; Softley, D. (AiResearch Mfg. Co. of Arizona, Phoenix (USA)). 12 Dec 1977. Contract EF-77-C-01-2611. 41p. Dep. NTIS, PC A03/MF A01.

The objective of this program is to advance high-temperature closed gas turbine power conversion systems to a point of technological readiness for use in coal fired public utility power conversion plants. The initial contract addresses two specific problem areas. These are: (1) The identification and analysis of system concepts which offer highest overall plant efficiency consistent with lowest cost of electricity (COE) from coal-pile-to-bus-bar; and (2) The identification and preliminary design of combustor/heat exchanger concepts compatible for use as the cycle gas primary heater for those plant systems. System cycle analyses and parametric studies will be performed to evaluate entire closed gas turbine utility power plants, with and without Rankine bottoming cycles with emphasis on lowest COE. Contract completion will result in utility plant layouts, component definitions, performance, technology assessment and costs for four heater systems. Two heater systems will be based on 1550°F closed gas turbine inlet temperature using metallic materials and two based on 1750°F and higher using non-metallic materials. Progress in each task in this program is reported.

26150 (JPRS—69811, pp 18-27) **Comparative evaluation of the technical and economic indices of MHD and thermionic add-on units for steam-turbine power plants.** Morozov, G. 19 Sep 1977. Translation of Technical report No. A 77/5, Institute of High Temperatures, Academy of Sciences USSR, Moscow, 1977, 13 pp.

In Translations on USSR science and technology. Physical Sciences and Technology No. 18.

The attainment of high efficiencies in steam-turbine [ST] power plants requires simultaneous increase in both the temperature and pressure of the superheated gas, which is an extremely complicated technical problem due to the low strength of structural materials at high temperatures. One way (and to all appearances the most promising way) to avoid the combined action of high temperatures and pressure on equipment is to supplement the steam-power cycle with a high-temperature add-on unit in which the working fluid is at a relatively low pressure. Two types of high-temperature add-on units (a thermionic energy converter [TEC] and an MHD generator [MHDG]) are discussed, and their technical and economic characteristics are examined. The following types of gas-operated electric power plants are compared: I-with ST, II-with TEC + ST, III-with MGDH + ST, IV-with MGDH + TEC + ST.

COMPONENTS

REFER ALSO TO CITATION(S) 26145, 26146, 26149, 26201, 26706

26151 (AED-Conf—77-195-006) **Prevention of fouling in waste-fired vessels.** Bereiter, R.; Nueesch, P. (Eidgenoessische Technische

Hochschule, Zurich (Switzerland)). 1977. 6p. (In German). Dep. NTIS (US Sales Only), PC A02/MF A01.

The flue gas deflection between two sets of multiple boilers causes uneven distribution of the flue gas flow and fly ash contamination. Therefore, convective heat exchangers have flow around them on one side, and tend to produce marked local fouling and/or erosion or HT corrosion damage in waste fired boilers. By installing a simple cooled deflection wall, the ash separation is increased by its acting as an ash filter flue gas deflector, and the flow round the subsequent set of boilers is improved. Fouling problems can thus be solved in an existing three set boiler and the HT corrosion damage due to excessive baked-on ash can be avoided.

26152 (FE—2556-09) **Development of a ceramic tube heat exchanger with relaxing joint. Quarterly technical progress report, July—October 1, 1977.** Ward, M.E.; Napier, J.C. (Solar Turbines International, San Diego, Calif. (USA)). 15 Oct 1977. Contract EF-77-C-01-2556. 65p. Dep. NTIS, PC A04/MF A01.

Room temperature and a high temperature (1204°C) radial compression strength tests have been completed on KT silicon carbide (Carborundum). Room temperature radial compression strength tests have been completed on sintered silicon carbide (NC-430), Norton and super KT silicon carbide (Carborundum). Weibull distributions have been generated. Environmental rig test of KT silicon carbide tubes with Homer City flyash at an air temperature of 1260°C and 1037°C and a tube temperature of 1148°C and 871°C was completed. Three distinct temperature zones were identified in tube rig tests for the Homer City power plant flyash; non-sticking, sticking and flyash melt-off. Results of flyash calibration tests performed on the environmental rig indicate that the initial test conditions cannot be run due to heavy flyash accumulations in short time intervals. New conditions are recommended. Preliminary thermal analysis of tube within a tube heat exchanger design indicates that it is a feasible design if higher pressure drops can be tolerated. A preliminary sketch of a counter-axial flow heat exchanger was completed. Preliminary thermal performance analysis on this design indicates that 800 feet of unfinned ceramic tubing would be needed in order to test a one pound per second air flow heat exchanger module that would meet the program's goals of 600°F air temperature rise with an exit temperature between 1800 and 2200°F. Late ceramic tube delivery is delaying material strength evaluation tests and material-environmental interaction tests.

26153 (NTIS/PS—77/0795) **Boiler corrosion (citations from the NTIS data base). Report for 1964—August 1977.** Smith, M.F. (National Technical Information Service, Springfield, Va. (USA)). Sep 1977. 107p.

Federally-funded research on design, efficiency, materials, cathodic protection, corrosion inhibiting additives, and combustion in coal and fuel oil fired boilers is cited. Studies on limestone injection for pollution control and its effect on boiler corrosion are included. The research also covers boilers in magneto-hydrodynamic power generation, ships, and nuclear power plants. (This updated bibliography contains 102 abstracts, 16 of which are new entries to the previous edition.)

26154 Effectiveness of high-sulfur oil combustion within range of loads in the furnace of the TGMP-314 steam generator. Mysak, I.S.; Kruk, M.T. *Therm. Eng. (USSR) (Engl. Transl.);* **24**: No. 1, 15-18(1978).

Translated from Teploenergetika; 24: No. 1, 15-19(Jan 1977).

Increasing the effectiveness of fuel combustion is of great importance for improving the efficiency of steam generators. For high-capacity steam generators operating at supercritical pressure operational efficiency is first of all ensured by setting up the optimal furnace process. Taking into consideration the great nonuniformity of the control load graph, effective combustion of fuel must be organized within a wide range of loads. Data are given from an investigation of the effectiveness of fuel combustion in the furnace of a TGMP-314 steam generator within a given load range. The investigations show that qualitative control of the combustion process with the aid of Titan atomizers is possible within the load range. Effectiveness of fuel combustion within the entire range of loads is ensured with the aid of atomizers calibrated with respect to capacity and spray angle, with nonuniformity of fuel distribution and sufficiently uniform distribution of air to burners. Change of the steam generator to operation at the lowest permissible excess air factors with proper organization of the furnace conditions does not decrease the reliability of the boiler equipment, but increases its efficiency and decreases the discharge of harmful nitrogen oxides.

26155 Corrosivity of flue gases from supercritical steam generators in operation on high-sulfur oil. Magadeev, V.Sh. *Therm. Eng. (USSR) (Engl. Transl.);* **24**: No. 1, 19-23(1978).

Translated from Teploenergetika; 24: No. 1, 19-23(Jan 1977).

Investigations of high-sulfur oil combustion in high-pressure steam generators have revealed the decisive part played by operational factors in the nature of burnout of fuel, formation of corrosive compounds, and toxic combustion products. It can be assumed that the level of corrosivity of combustion products of high-sulfur oil depends to no less degree on the design of the furnace chamber and the method of fuel combustion. Results are discussed of investigations carried out on series-manufactured TGMP-114 and TGMP-314 super-critical steam generators designed to burn high-sulfur oil and natural gas. The TGMP-114 steam generator, 900 t/h in capacity, consists of two symmetrical furnaces and is designed for superheated steam conditions of 565/570°C, 25.5 MPa. Minimal corrosion of airheater packing is attained with combustion of high sulfur oil at low excess air factors in combination with effective regular cleaning and preheating of air in heating elements.

26156 Optimal maintenance of main steam parameters in accordance with load of a generating unit. Shapiro, V.I. *Therm. Eng. (USSR) (Engl. Transl.);* **24**: No. 1, 31-33(1978).

Translated from Teploenergetika; 24: No. 1, 37-39(Jan 1977).

Calculations are given showing that a change from operation at rated parameters to operation at optimal pressure ensures a saving in fuel of up to 1400 to 4000 tons standard coal a year per 300 MW generating unit (depending on the load graph). Change to maintaining the optimal complex of main steam parameters (pressure and temperature) leads to increase in saving, up to 1700 to 4500 tons standard coal/year. The additional gain is not great but one should remember that attaining it does not require significant complication of the control circuit while the mode of its operation becomes appreciably simpler.

26157 Development of the furnace process with various vortex burner arrangements. Shnitser, I.N.; Shagalova, S.L.; Yur'ev, L.V.; Shapovalov, Yu.I.; Merezhko, V.P.; Plaksin, O.T. *Therm. Eng. (USSR) (Engl. Transl.);* **23**: No. 11, 50-55(Nov 1977).

Translated from Teploenergetika; 23: No. 11, 50-55(Nov 1976).

To establish the intensity of development of the processes of intermixing and igniting of pulverized fuel (pf)/air streams and the corresponding efficiency of burning coal, a comparative study was made of combustion and heat transfer in TPP-210 and TPP-210A steam generators with two-tier and single-tier arrangement of burners, 35 and 70 MW in thermal output. The furnace chamber of the TPP-210 steam generator differs from the furnace of the TPP-210A mainly in the halved unit output of the two-scroll burners, positioned opposite one another in two tiers. The main design characteristics of the investigated furnaces and of the burners, as well as the swirl parameters of the burners, determined in accordance with the OST standard, are shown. Velocity field, temperature field, fields of distribution of gas composition and of p.f. concentration and of combustibles in the p.f. were determined. Investigation and processing of the experimental material were carried out. At the same time the necessary balance variations and calculations, characterizing the operation of the steam generators over the period of the investigations, were conducted. Operational parameters of the furnaces and burners, as well as qualitative characteristics of the anthracite burned are given. The distribution of fields of velocities, temperatures, concentrations of CO_2, O_2, CO, combustibles and p.f. over the cross section of the furnace of the TPP-210 steam generator at different distances from the burners is given.

26158 Stabilization treatment of return cooling water with phosphonates. Maklakova, V.P.; Bondar, Yu.F.; Gronskii, R.K.; Kolokolov, N.E.; Dzyuba, N.E.; Golev, Yu.D. *Sov. Power Eng. (Engl. Transl.);* **6**: No. 9, 529-531(Sep 1977).

Translated from Elektr. Stn.; 6: No. 9, 36-37(Sep 1977).

The study described was the first domestic test of use of phosphonates for dealing with scale formation. The results show the promise of using OEDP (oxyethylidenediphosphonic acid) for treatment of the cooling water of thermal power stations with a return cooling system with cooling towers or sprayer ponds.

26159 High pressure single-housing collector preheaters for the 800 MW power unit. Polynovskii, Ya.L.; Marushkin, V.M.; Kul'mukhametov, T.Ya.; Antonov, N.M.; Bakulenko, B.F.; Podgorochnyi, P.I.; Ovcharenko, N.G. *Sov. Power Eng. (Engl. Transl.);* **6**: No. 9, 540-543(Sep 1977).

Translated from Elektr. Stn.; 6: No. 9, 43-57(Sep 1977).

Large high pressure preheaters (HP's) for 500 to 1200 MW power units using 32 mm tubes are unacceptable for 800 to 1200 MW units for modern turbine plants. There is, however, a significant decrease in the consumption of metal and the cost of the HP with decrease in tube diameter. Single housing HP's are proposed which will have somewhat better thermotechnical characteristics and will provide a substantial saving of metal per power unit. (PMA)

26160 Formation of deposits of poorly soluble corrosion products. Romanov, V.A.; Kalmykov, A.N. (Leningrad Shipbuild Inst, USSR). *Izv. Vyssh. Uchebn. Zaved., Energ.;* No. 7, 62-67(Jul 1977). (In Russian).

A physical model of the process of formation of particles of a water-repellant colloid on the inner surfaces of steam turbine plant tracts is proposed. A mathematical description of the process is

given for the case of turbulent conditions of flow of the working medium. Results of the calculations according to the proposed model roughly agree with the experimental data regarding the formation of iron oxide deposits.

26161 Selection of tube spacings of gastight enclosures of convective shafts of high-capacity boiler units. Akimov, Yu.I.; Suntsov, A.N. (Saratov Polytech Inst, USSR). *Izv. Vyssh. Uchebn. Zaved., Energ.;* No. 7, 86-91(Jul 1977). (In Russian).

It is proposed to use overall rated expenditure as the economic criterion in selecting design characterics of gastight enclosures of convective shafts of boiler units. An analytical method of determination of economically most convenient spacings of such enclosures is presented. As an example, selection of the spacing of a gastight waterwall consisting of pipes 32*6 forming the convective shaft of a boiler for a 1200 NW power unit is considered.

26162 Mathematical model of a direct-flow boiler with stream heating. Kalafati, D.D.; Petrov, S.I.; Borisov, G.M. (Moscow Power Eng Inst, USSR). *Izv. Vyssh. Uchebn. Zaved., Energ.;* No. 6, 59-64(Jun 1977). (In Russian).

A method is proposed and coupling equations are obtained for six-factor target functions of a direct-flow boiler with steam heating. It makes use of the method of experiment planning relying on variant calculations according to an ALGOL program utilizing regression analysis within a wide range of variation of principal parameters. An example of a graphic representation of the results is given.

26163 Effect of the radial gap on the efficiency of axial unshrouded turbine stages. Sherstyuk, A.N.; Chizhov, V.V. (Moscow Inst of Chem Mach, USSR). *Izv. Vyssh. Uchebn. Zaved., Energ.;* No. 6, 137-141(Jun 1977). (In Russian).

A refined model of the flow in the radial gap between the rotor blades and the turbine casing is proposed. On the basis of this model, a method of calculation of the losses in the gap is developed. It is shown that the proposed method permits more exact determination of the efficiency of the turbine stage than the known relations published so far.

26164 Improvement of the design of Type P-57 boiler relying on the experience of its operation at the troitskaya district power station. Sotnikov, I.A.; Aizen, Kh.k.; Petrov, E.V. (Podol'sk Mach Works, USSR). *Teploenergetika (Moscow);* No. 6, 2-5(Jun 1977). (In Russian).

Brief data are presented about the P-57 boiler of a 500 MW power block fired by Ekibastuz coal varieties. Measures taken on the basis of the initial experience of operation of the boiler and aimed at improving its reliability are described.

26165 Boiler for an 800 MW power block fired by Ekibastuz coal. Aizen, Kh.K.; Vasil'ev, Kh.K.; Vukolova, A.A.; Ivanov, A.G.; Petrov, E.V.; Chakrygin, V.G.; Chernigin, S.P.; Shchelokov, V.I. (Ural Heat Eng Inst, USSR). *Teploenergetika (Moscow);* No. 6, 5-7(Jun 1977). (In Russian).

A boiler having a steam output capacity of 2650 t/h and designed for operation with an 800 MW power block burning Ekibastuz coal with the average ash content of 445 and maximum ash content of 485 is described.

26166 Investigation of contamination and corrosion of regenerative air preheaters during combustion of Ekibastuz coal. Dombrovskii, V.I. (Ural Heat Eng Inst, USSR). *Teploenergetika (Moscow);* No. 6, 7-10(Jun 1977). (In Russian).

Results of experimental and industrial corrosion of regenerative air preheaters (RAP) when Ekibastuz coal is burned are presented. It is found that intensive contamination and corrosion of RAP packing is observed at the average metal temperature of below 70 C. In order to protect RAP from corrosion and contamination, the rated temperature of the packing must not be below 80 C.

26167 Effect of regime parameters of boiler operation on abrasive properties of Ekibastuz coal ash. Nekrasov, V.G.; Bogatkin, V.I.; Dakhov, A.I.; Diambekov, S.S.; Timchenko, A.V.; Chayanov, V.A. (Kazenergonaladka, Kaz SSR). *Teploenergetika (Moscow);* No. 6, 10-12(Jun 1977). (In Russian).

In view of the wide application of the Ekibastuz coal with high abrasiveness of its fly ash, the abrasive properties of the latter and the effect on it of the regime parameters of boiler operation are studied. The results of investigations of industrial boilers show that, for boilers with open chamber furnaces and dry slag removal, an increase in load results in an increase in the abrasive properties of ash.

26168 Air preheater made of corrugated tubes. Rudenko, I.m.; Spodyryak, N.T. (Sci Res Energ Inst, Kaz SSR). *Teploenergetika (Moscow);* No. 6, 12-14(Jun 1977). (In Russian).

Based on results of experimental investigations and calculations, it is shown that the application of corrugated tubes as heating surfaces of recuperative air preheaters may sharply improve the performance of the latter.

26169 Ways to improve the technical level of operation of Ekibastuz coal-fired boilers. Levit, G.T.; Pugach, L.I.; Serant, F.A.; Dudorov, Yu.D. (ORGRES, USSR). *Teploenergetika (Moscow);* No. 6, 19-22(Jun 1977). (In Russian).

The difficulties connected with operation of boiler on Ekibastuz coal are mainly due to its high average ash content (42%) and even more so to the instability of its ash content. Investigations on some existing power plants show that contamination of furnaces fired by Ekibastuz coal can be considerably reduced by increasing the pulverized fuel particle size to R$sub 90$=25--305 and by increasing the rate of flow of gases past waterwalls.

26170 Experimental investigation of the effect of regime factors on the economic efficiency of the TP-230B boiler simultaneously burning anthracite fines and residual oil. Borisov, G.M.; Girshfel'd, V.Ya.; Kulikov, V.E. (Moscow Energ Inst, USSR). *Teploenergetika (Moscow);* No. 6, 22-25(Jun 1977). (In Russian).

Results of thermal tests of the TP-230B boiler simultaneously burning anthracite fines and residual oil are presented. The investigations involved the use of the experiment planning method in the form of multifactorial characteristics. Relations are obtained in the form of a second power polynomial reflecting the influence of the main factors that vary in the course of operation and their effect on the economics efficiency of the boiler.

26171 Effect of temperature pulsations of the lower radiant section tubes on their service life. Shakhsuvarov, K.L.V.; Chetverikov, V.A.; Yalova, A.Ya. (OGREs, USSR). *Teploenergetika (Moscow);* No. 6, 25-28(Jun 1977). (In Russian).

The 10-year old experience of operation of gas and residual oil-fired supercritical pressure boilers shows that the lower radiant section (LRS) remains their least reliable part. Oscillographic recording of tube metal temperature of LRS at the Kostroma district power station was carried out to test the hypothesis that tube fatigue phenomena observed might be caused by periodic metal temperature fluctuations. This hypothesis has proved to be correct. Likewise, tests on analog models show that metal temperature fluctuations are connected with fuel spray pulsations in the furnace. The fluctuations can be reduced by lowering tube metal temperature. This can be achieved through the lowering of the rate of increase of metal temperature to 5$degree$C/1000 hr by utilizing feedwater treatment with complexing agents, carrying out chemical cleaning of the LRS once every 18 months only.

26172 Investigation of cooling-down conditions of the K-200-130 turbine of a drum boiler-type power block. Avrutskii, G.D.; Gutorov, V.F.; Tugov, A.I. (All-Union Heat Eng Inst, USSR). *Teploenergetika (Moscow);* No. 5, 34-37(May 1977). (In Russian).

Results of investigations of forced cooling-down of a K-200-130 turbine, working in a power block with drum-type p.f.-fired boiler, when it is shut down for planned or emergency repair, are presented. The possibility of cooling down the stopped turbine within 33-38 h to a temperature of 170$degree$C with an extinguished boiler, without preliminary cooling-down under load, is demonstrated. The cooling-down of the high-pressure cylinder is carried out by the steam produced in the boiler after the disconnection of fuel supply.

26173 Concentration of temperature stresses in thermal grooves of integral-disk rotors. Trukhnii, A.D.; Shatin, S.A. (Moscow Power Eng Inst, USSR). *Teploenergetika (Moscow);* No. 5, 38-41(May 1977). (In Russian).

Results of investigation of the effect of geometric parameters and operating condition characteristics on thermal stresses in turbine rotors in the area of thermal grooves are presented. It is found that the radius of the groove, even more than the depth of the groove or the temperature field, has the decisive effect on the thermal stresses.

26174 Chemical purging of K-300-240 turbines made at Kharkov Turbogenerator Works during overhauls. Kleimenov, N.G.; Andryushin, V.M.; Korzhov, E.N.; Agapova, A.V. *Teploenergetika (Moscow);* No. 5, 45-46(May 1977). (In Russian).

Results of two purging of steam turbines by a solution of Trilon B in the course of overhaul are summarized. Experiments have demonstrated high efficacy of this type of purging. Recommendations are given on introducing this kind of purging during turbine overhaul.

26175 Obtaining thermal experimental multifactorial analytical characteristics of turbo-sets by utilizing the experiment planning method. Borisov, G.M.; Girshfel'd, V.Ya. (Moscow Energ Inst, USSR). *Teploenergetika (Moscow);* No. 5, 47-49(May 1977). (In Russian).

The method is set forth and results are presented in the form of thermal experimental multifactorial analytical characteristics for the turbo-sets, PT-60-130 LMZ and VT-25-90 BMZ, obtained as a result of thermal tests with utilization of the experiment planning method for condensing and district-heating modes of operation.

26176 Automation of a power block with combined circulation of a medium in the boiler under normal operating and emergency load-shedding conditions. Livshits, M.A.; Dubov, V.N.; Dumnov, V.P.; Bukharov, V.P.; Mikhailov, S.Ya.; Ziskand, G.A.; Nosov, B.N.; Bogomaz, V.N. (All-Union Heat Eng Inst, USSR). *Teploenergetika (Moscow);* No. 5, 50-53(May 1977). (In Russian).

Tests of the automatic control of the gas-tight TGMP-324 steam generator with combined circulation of the medium under normal and breakdown conditions of operation are described. Operation within the load range of 100-30% is investigated. It is found that the control system developed ensures a fairly high quality of maintaining steam parameters within the load range of 35-100% of the rated value. The automatic system of emergency load shedding ensures reliable transfer of the power block to low loads, including idle run, down to 30% of the rated load.

26177 Comparison of heat transfer efficiency of gases flowing in smooth and rough channels. Kalafati, D.D.; Popalov, V.V. (Moscow Power Eng Inst, USSR). *Teploenergetika (Moscow);* No. 5, 70-73(May 1977). (In Russian).

By means of a theoretical analysis and experimental data, it is shown that utilization of rough-surface tubes in heat exchangers is more effective than that of smooth tubes.

26178 Flow stability in heated channels in the transcritical region of the parameters of state. Treshchev, G.G.; Sukhov, V.A. (All-Union Heat Eng Inst, USSR). *Teploenergetika (Moscow);* No. 5, 79-81(May 1977). (In Russian).

A method of calculation of the stability of supercritical pressure boilers is proposed, taking into account the temperature profile across the section of the flow. Calculation results are compared with experimental data showing satisfactory agreement between them.

26179 Effect of thermal resistance of network water heaters on the operation of a t-250/300-240 turbine plant in variable conditions. Gonchar, v.K.; Monakhov, Yu.S. (Kiev Polytech Inst, Ukr SSR). *Izv. Vyssh. Uchebn. Zaved., Energ.;* No. 4, 67-72(Apr 1977). (In Russian).

Results of investigation of the effect of variation of heat transfer coefficients in turbine plant network water heaters with stepwise heating of network water on the capacity developed and on the economic efficiency indices of a T-250/300-240 turbine, for different values of electric and thermal load, are presented. Generalized analytical relations for turbine capacity losses following an increase in thermal resistance of the top and bottom network water heaters separately are presented. Appropriate nomograms are given.

26180 Kawasaki PU200 gas turbine power generator. *Kawasaki Giho;* No. 63, 280-282(Mar 1977). (In Japanese).

By linking a generator with a Kawasaki S1A gas turbine, an original gas turbine power generator PU200 having a capacity of 150 kilowatts was developed. The S1A is the first gas turbine among a series of turbines originally developed by Kawasaki. Having a simple open cycle, single shaft, it was designed and tested for emergency use. The standard system consists of turbine and generator unit, cubicle type battery unit, automatic start and switch gear console and other small components such as fuel tank and remote operation panel. In July 1976 the system was fully qualified under the quality requirements of the Japanese fire code.

26181 Electric power from containers. Heinrich, R.A. *Zivilverteidigung;* No. 2, 55-59(1977). (In German).

Mobile power stations can be useful where shortages of supply have to be overcome as quickly as possible and where there are peak demands over short periods only. The article describes the problems which are to be solved when power stations of this kind are constructed and put into operation. Illustrated by examples, experience made so far is reported on.

26182 Technology of acoustic pipe cleaning at power engineering plants. Krupenikov, V.V.; Kuznetsova, E.M.; Poddubnyi, B.N. *Energomashinostroenie;* No. 6, 34-35(1977). (In Russian).

Results of investigations of detergent substances for different contaminations and pipe types are considered. The superiority of acoustic cleaning compared with the chemical cleaning is demonstrated. Application of both alkaline solutions or two-phase media and a combination of the acoustic field with the electrochemical one makes it possible to improve the quality of cleaning and to cut down the waste due to intercrystalline corrosion.

26183 Manufacture of an experimental batch of convective heating surfaces for the Lithuanian district power station. Shul'man, I.E.; Vailov, G.M.; Babin, S.A.; Levchenko, G.I. (PO "Krasnyi Kotel'shchik", USSR). *Energomashinostroenie;* No. 7, 33-34(1977). (In Russian).

Data are given on the technology of manufacture of a secondary first-stage membrane superheater bank and of all-welded waterwalls. These designs of the secondary membrane superheaters yield considerable metal savings, contribute to the reduction of their size, simplification of fixtures, to the reduction of the intensity of slagging, and widen the structural layout possibilities.

26184 Full scale tests and thermal design correlation for coiled once-through steam generators. Campolunghi, F.; Cumo, M.; Ferrari, G.; Palazzi, G. (C.N.E.N., Lab di Scambio Termico, Rome, Italy). *AIChE Symp. Ser.;* **73**: No. 164, 215-222(1977).

Full scale heat transfer tests have been performed in a coiled once-through steam generating tube (D(tube=0.0155 m, D(coil)=0.836 m), with subcooled water at inlet and superheated steam at outlet. It is concluded that designers may consider a boiling length extended up to 100% quality. Along this length (an important one of steam generators) a mean boiling heat transfer coefficient is suggested. Internal and external side heat transfer coefficients, in the superheated steam region of the coil, may differ up to 100% and more.

26185 Design development and experience of operation of a high-temperature residual oil preheater. Bulgakov, V.G. (Orenburgenergo, USSR). *Energomashinostroenie;* No. 7, 35-37(1977). (In Russian).

The design, some test data and experience of operation of a high-temperature residual oil preheater for supercritical pressure boilers of 300 MW power units are set forth. Likewise, the main characteristics of the preheater and comparative data are presented.

26186 Protection of steel and zinc-alloyed steel in power plants with Goldschmidt-products. Geiss, K. *Goldschmidt Informiert;* **3**: No. 38, 47-48(Nov 1976). (In German).

WASTE HEAT UTILIZATION

REFER ALSO TO CITATION(S) 26570

26187 Unit-type power stations as elements for district heating. Principle: Heat-power coupling is systematically utilized. Hein, K. (Stadtwerke Heidenheim A.G. (Germany, F.R.)). *Beratende Ing.;* No. 7/8, 22-25(1976). (In German).

The paper reports on the improvement of the efficiency of power stations for electricity generation by means of heat-power coupling and on the experience made with a unit-type heating power station of Heidenheim promoted by the Federal Government. The waste heat of motors and turbines is used for the heat supply of surrounding objects. The heat from cooling circuits and exhaust gases is fed into the supply grid through heat exchangers. The operation is fully automated. If natural gas is used, the power supply is relatively secure. The importance and the performance of the unit-type heating power stations for the purposes of district heating is explained.

26188 New heat and power package is leaping over the final hurdle. Butler, P. *Engineer;* **245**: No. 6339, 59(22 Sep 1977).

A dual-purpose power plant for the co-generation of electricity and process heat is planned. The plant will use diesel engines, waste heat boilers, and economizers for additional heat recovery to preheat boiler feedwater. (PMA)

ECONOMICS

26189 (EPRI-AF—610) Combined cycle power plant, capital cost estimates. Final report. (Bechtel Power Corp., San Francisco, Calif. (USA)). Dec 1977. 67p. Dep. NTIS, PC A04/MF A01.

Capital cost estimates were prepared for oil-fueled, high-efficiency combined gas turbine/steam turbine power plants in five regions of the United States: Great Lakes, Southwest, Western (at two locations), Northeast, and Southeast. These plants are designed to burn liquid fuels, either distillate (kerosene and No. 2 distillate) or ash-bearing (blended residuals, crudes, and heavy residuals). Plants have either a nominal net combined power output of 250 MWe for a single-unit installation or 500 MWe for a two-unit installation consisting of two 250-MWe units. All plants are designed to meet present-day environmental regulations, EPA New Source Performance Standards; and in addition, one of the Western plants--located in the Southern California Metropolitan Area (Los Angeles)--is designed to meet the special pollutant limitations in that area. Capital costs for the 250-MWe plant expressed in 1976 dollars range from $306/kW for a Southwestern plant burning distillate fuel to $417/kW for a remote Western plant burning residual fuel. The costs in $/kW for the 500-MWe plants are about five percent lower. Cost estimates were based on information from recent and current construction projects for both conventional and combined-cycle plants, and incorporate present-day criteria regarding releases to the environment. The costs also include an allowance for funds during construction and other owner costs. Trends in future development of combined-cycle plants are also discussed.

26190 (ORNL/TM—6230) User's instructions for preliminary version of the CONCEPT-5 computer code. Hudson, C.R. II. (Oak

Ridge National Lab., Tenn. (USA)). 26 Jan 1978. Contract W-7405-ENG-26. 57p. Dep. NTIS, PC A04/MF A01.

In an effort to increase user flexibility and produce more accurate conceptual cost estimates of electric power generating plants, the CONCEPT-5 computer program package was prepared. Delays in acquiring certain cost data necessitate the release of a preliminary version of the CONCEPT-5 code. By doing so, new cost data already available may be utilized until a final version is issued. This report contains instructions on loading the programs into the computer, a description of the cost models presently available, input requirements and operating features, and example cases. This report assumes the reader has familiarity with the prior version of the code described in ERDA-108.

FUELS

REFER ALSO TO CITATION(S) 25722

26191 (NTIS/PS—77/0796) **Boiler corrosion. Volume 2. 1975—August, 1977 (citations from the Engineering Index Data Base). Report for 1975—August 1977.** Smith, M.F. (National Technical Information Service, Springfield, Va. (USA)). Sep 1977. 249p.

Worldwide research on materials, fuel types, fuel impurities, additives, efficiency, inhibitors, and combustion are cited. Boiler corrosion studies related to pollution control, feedwater treatment, testing, and boiler design are also included. (This updated bibliography contains 242 abstracts, 141 of which are new entries to the previous edition.) See also NTIS/PS-76/0603, Boiler Corrosion. Vol. 1. 1973-1974.

ENVIRONMENTAL ASPECTS

REFER ALSO TO CITATION(S) 26932

26192 (EPA—600/9-77-013) **Advanced fossil fuel and the environment: an executive report.** (Environmental Protection Agency, Washington, D.C. (USA)). Jun 1977. 27p. NTIS.

The environmental control technologies being developed in conjunction with advanced fossil fuel conversion processes are briefly reviewed. These programs include chemical coal cleaning, synthetic fuels, chemically active fluid bed, oil shale, and liquid fuels cleaning. Comparative economics of sulfur control and a reading list are included. (LTW)

NOXIOUS GAS AND PARTICULATE ABATEMENT AND CONTROL

REFER ALSO TO CITATION(S) 25678, 25680, 26130, 26154

26193 (PB—273019) **Energy consumption of environmental controls: fossil fuel, steam electric generating industry. Final report.** Murphy, B.; Mahoney, J.R.; Bearg, D.; Hoffnayle, G.; Watson, J. (Environmental Research and Technology, Inc., Concord, Mass. (USA)). Aug 1977. 199p. (ERT-P—1839). NTIS PC A09/MF A01.

The report addresses the energy requirements for environmental control in the fossil fuel, steam electric industry. These requirements arise through a number of mechanisms, including: direct fuel or electricity requirements for operating pollution control equipment, including production of necessary chemicals and disposal of wastes; energy used in constructing control equipment; fuels consumed in transporting low sulfur fuels; extra fuel consumed to compensate for power plants' efficiency losses caused by environmental controls; and energy used in constructing extra generation capacity to compensate for efficiency losses. These requirements are computed for a variety of energy policy 'scenarios' to demonstrate the impact of altering current environmental regulations or of utilizing alternate strategies for achieving environmental goals. In particular, the effect of requiring 'Best Available Control Technologies' for power plants, of using tall stacks and/or supplementary control systems, and of using coal washing and/or blending to decrease the necessity for 'scrubbers' are examined in different scenarios.

26194 (TID—28141) **Status of flue gas desulfurization applications in the United States: a technological assessment.** (Federal Power Commission, Washington, D.C. (USA). Bureau of Power). Jul 1977. 81p. Dep. NTIS, PC A05/MF A01.

A survey of the status of technology for the desulfurization of stack gases from coal-burning electric power plants is presented. This is intended to be a basic reference and information source for decision makers who are not specialists in the field. No attempt is made to provide ultimate conclusions, although there are a number of specific findings. It is primarily a descriptive assessment. Information is included on the operation, performance, and economics of scrubbers, advanced flue gas desulfurization processes, cool cleaning operations, and unresolved problems. (LCL)

26195 **Influence of exhaust gas recirculation on the formation of nitrogen oxides during the burning of oil.** Krutiev, V.A.; Efendiev, T.B.; Gorbanenko, A.D.; Yenyakin, Yu.P. *Sov. Power Eng. (Engl. Transl.);* **6**: No. 9, 518-521(Sep 1977).

Translated from Elektr. Stn.; 6: No. 9, 28-30(Sep 1977).

In spite of a number of drawbacks of forced recirculation of exhaust gases (increase of the capital costs in construction of the boiler units, increase of the electrical energy consumption for station service, limitation of the possibilities of gas recirculation for regulation of the steam superheating) the use of forced recirculation is favorable, since at the present time it provides the most effective (by a factor of 2 to 2.5) decrease in the discharge of nitrogen oxides and significantly eases the operation of the metal steam generating heating surfaces in the zone of maximum heat formation due to the decrease in the falling thermal flux.

26196 **Studies on nitrogen oxides removal from flue gas (No. 2).** Hori, K.; Taguchi, Y.; Itoh, H.; Niwa, S.; Tominaga, S.; Okamoto, T. *Kawasaki Giho;* No. 63, 161-166(Mar 1977). (In Japanese).

The technology to reduce NO/sub x/ from fixed sources by researching and developing various NO/sub x/ removal processes is discussed. A 5000 Nm^3/h pilot plant for the wet simultaneous NO/sub x/ and SO/sub x/ removal process by magnesium hydroxide at Takahara Power Station of Electric Power Development Company Ltd. in Hiroshima Prefecture has been constructed. The feasibility of the process was investigated using flue gas from the power station for about one year. The pilot plant was successfully tested at 80% NO/sub x/ removal efficiency and 90% SO/sub x/ removal efficiency.

POWER TRANSMISSION AND DISTRIBUTION

26197 (NTIS/PS—77/0690) **Electric power load management (citations from the NTIS data base). Report for 1964—July 1977.** Reed, W.E. (National Technical Information Service, Springfield, Va. (USA)). Aug 1977. 57p. Technical Information Service, Springfield, VA.

The potential, enabling technology, and impact on utilities and consumers are investigated in the cited Government-sponsored research reports. Topics included are load leveling, rate structures, off-peak power storage and utilization, energy conservation, and digital simulation and control. (Contains 52 abstracts)

26198 (PB—271083) **Impact of load management strategies upon electric utility costs and fuel consumption. Final report.** (Federal Energy Administration, Washington, D.C. (USA). Office of Energy Conservation and Environment). Aug 1976. Contract FEA-CO-04-50230-00. 151p. (SCI—6811). NTIS PC A08/MF A01.

This report provides an analysis of the potential benefits to electric utilities from the implementation of load management. Reductions in operating costs were calculated, using a probabilistic simulation of the operation of two representative electric utilities. Three specific strategies, time-of-day rates, remotely controlled water heaters, and improved residential insulation were tested. A brief analysis was made of additional benefits from reductions in capital expenditures.

26199 **Characteristics of fault locating instruments.** Belyakov, Yu.S.; P'yankov, V.Ya. *Sov. Power Eng. (Engl. Transl.);* **6**: No. 9, 553-555(Sep 1977).

Translated from Elektr. Stn.; 6: No. 9, 67-76(Sep 1977).

Regression analysis should be used in analyzing the instrument calibration data. In calibrating the instrument the number of measurements should be not less than 10 and may be corrected with accumulation of experimental data. A linear equation in logarithmic coordinates does not properly describe the relationship between the instrument reading in scale divisions and the electrical quantity. The introduction of a quadratic term into the equation gives a significant improvement. The detection of characteristic curves containing gross errors should be performed using the residual mean square deviation.

AC SYSTEMS, EHV AND UHV

26200 (PB—271652) **Alternative electrical transmission systems and their environmental impact.** Schiefelbein, G.F. (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). Aug 1977. Contract ERDA-EY-76-C-06-1830. 208p. NTIS PC A10/MF A01.

The report provides a general description of electrical transmission systems as an aid to the NRC in determining their environmental impacts. Alternating current and direct current overhead and underground systems and their potential impacts are treated in sufficient detail for this purpose.

26201 **Flexible couplings between power plant main buildings and 500 kV open distribution units using lateral loops.** Markov, G.A. *Sov. Power Eng. (Engl. Transl.);* **6**: No. 9, 550-552(Sep 1977).

Translated from Elektr. Stn.; 6: No. 9, 64-66(Sep 1977).

The use of balance suspensions on power station 500 kV flexible connections permits a significant decrease in the space occupied by the flexible connections due to the possibility of using single-upright towers with vertical placement of the phase conductors and due to the elimination of the arms and spreader suspension insulation, improving the operational reliability of the flexible connections. It should be assumed that the use of the balance suspensions at 750 kV would provide even greater efficiency, but a 750 kV design has not yet been developed.

NUCLEAR POWER PLANTS

26202 (COO/4121—2(Vol.1)) **Delays in nuclear power plant construction. Volume I. Final report.** (Ohio State Univ., Columbus (USA). Dept. of Botany and Plant Pathology). 14 Dec 1977. Contract EY-76-S-02-4121. 215p. Dep. NTIS, PC A10/MF A01.

The report identifies barriers to shortening nuclear power plant construction schedules and recommends research efforts which should minimize or eliminate the identified barriers. The identified barriers include: (1) Design and Construction Interfacing Problems; (2) Problems Relating to the Selection and Use of Permanent Materials and Construction Methods; (3) Construction Coordination and Communication Problems; and (4) Problems Associated with Manpower Availability and Productivity.

26203 Results of German nuclear power plant operation 1976. Pt. 2. From the annual report of the ABE board of the Deutsches Atomforum. *Atomwirtsch., Atomtech.;* **22**: No. 11, 585-590(Nov 1977). (In German).

In 1976, the installed power of German nuclear power stations had an 80% increase to 6,454 MWe, due to the start-up of GKN, KKB, and Biblis B. However, as these plants were started up relatively late in the year, gross power generation increased only to 24,800 GWh from a gross 21,800 GWh in 1975. This is about 7.5% of the total power generated. The present part of the report gives operational experience from KRB Gundremmingen, KWO Obrigheim, MZFR, AVR, KNK, and VAK.

26204 Civil engineering construction in conventional thermal power stations and nuclear power stations. Wehr, J. (Rheinisch-Westfaelisches Elektrizitaetswerk A.G., Essen (Germany, F.R.)). *VGB Kraftwerkstech.;* **57**: No. 4, 269-283(Apr 1977). (In German).

In spite of the increasing use of reinforced concrete in nuclear power stations, which is required because of more stringent safety requirements, there still exists for steel an essential field of application in the area of safety provisions. Because of technical safety conditions increasing requirements for quality, precision of installation and testing of steel structures are therefore necessary. This also applies to the individual buildings in conventional thermal power stations.

26205 Civil engineering work. Cousyn, Rene; Goubin, Jean. *Rev. Gen. Nucl.;* No. 3, 196-203(1977). (In French).

Although it does not require a specifically new technicality, the Civil Engineering of a nuclear power plant site is complex work. Considering as an example the power plant currently in construction at Tricastin, the authors describe the main Civil Engineering work and task organization applied to carry it out.

26206 Nuclear power. Its development in the United Kingdom. Pocock, R.F. London; Unwin Brothers and The Institution of Nuclear Engineers (1977). 272p.

The subject is covered chronologically in chapters, entitled: from war to peace; the Atomic Energy Authority and the first nuclear power station; a civil power programme; Windscale - the need for caution; research for the future; the new (Magnox) power stations; revision of the nuclear power programme; supply of nuclear fuels; nuclear power for ship propulsion; completion of first programme; Dungeness B and second programme, political assessment of (nuclear) industry's structure; reorganization of the industry; nuclear power in the environment; completion of second programme; the energy crisis; decision on third programme.

POWER REACTORS, NON-BREEDING, LIGHT-WATER MODERATED, BOILING WATER COOLED

REFER ALSO TO CITATION(S) 26190, 26305, 26437, 26438, 26444, 26448

26207 (NEDO—24057) **Assessment of reactor internals vibration in BWR/4 and BWR/5 plants.** Gilman, J.D.; Duckwald, C.S.; Umble, D.G. (General Electric Co., San Jose, Calif. (USA). Boiling Water Reactor Systems Dept.). Nov 1977. 67p. Electric Co., San Jose, CA.

This report presents results of reactor internals vibration tests and measurements conducted in prototype BWR/4 plants of 251 inch, 218 inch, and 183 inch vessel sizes. Results are also presented for supplemental tests of certain internal design features of later BWR/4 plants. All results are shown to be within acceptable limits. Visual inspections of internals following flow testing showed no evidence of vibration. Plans are outlined for additional vibration measurements in BWR/4 and BWR/5 plants containing new design features. Confirmatory test plans for subsequent similar BWR/4 and BWR/5 plants are discussed.

26208 (NEDO—24076) **Design report and safety evaluation for high density fuel storage system. Licensing topical report.** Lantz, L.L. (General Electric Co., San Jose, Calif. (USA). Boiling Water Reactor Systems Dept.). Nov 1977. 55p. Electric Co., San Jose, CA.

This report describes the high density fuel storage rack to be used to store BWR fuel. The analysis concludes that this rack is usable under all expected conditions and causes no change in the environmental concerns.

26209 (NUREG—0020(Vol.2)(No.1)) **Licensed operating reactors. Operating units status report, data as of 12-31-77.** Cintula, T.C. (ed.). (Nuclear Regulatory Commission, Washington, D.C. (USA)). Jan 1978. 186p. NTIS $10.00.

The U. S. Nuclear Regulatory Commission's monthly Operating Units Status Report—Licensed Operating Reactors provides data on the operation of nuclear units as timely and accurately as possible. This report is divided into three sections: the first contains monthly highlights and statistics for commercial operating units, and errata from previously reported data; the second is a compilation of detailed information on each unit, provided by NRC Regional Offices and IE Headquarters; and the third section is an appendix containing comparative statistics of U. S. nuclear/fossil capacity, identification of nuclear power plants within regional Electric Reliability Councils, the relative status of U. S. nuclear electric production to all U. S. electric production by state, and selected Edison Electric Institute operating statistics.

26210 (NUREG—0030-78/01) **Nuclear power plants. Construction status report, data as of December 31, 1977.** (Nuclear Regulatory Commission, Washington, D.C. (USA)). Jan 1978. 231p. NTIS $10.00.

This management report is designed to provide the necessary information for monitoring the progress of construction of nuclear power plants. It provides data for synchronizing the licensing process with predicted fuel loading dates, as well as providing a central federal government report for commercial reactor construction. The status of the 96 plants authorized to engage in construction activities in Regions I thru V is summarized in this document. This total includes (4) plants with construction exemptions, and (10) plants with Limited Work Authorization Permits.

26211 (ORNL/TM—6130) **Chemical thermodynamics of the system Cs—U—Zr—H—I—O in the LWR fuel-clad gap.** Besmann, T.M.; Lindemer, T.B. (Oak Ridge National Lab., Tenn. (USA)). Jan 1978. Contract W-7405-ENG-26. 25p. Dep. NTIS, PC A02/MF A01.

Equilibrium thermodynamic calculations were performed on the are Cs-U-Zr-H-I-O system that is assumed to exist in the fuel-clad gap of light water reactor fuel under in-reactor, steam, and 50% steam—50% air conditions. The in-reactor oxygen potential is assumed to be controlled by UO/sub 2+x/ rather than Zr + ZrO_2. Thus, the important condensed phases present are UO/sub 2+x/, Cs_2UO_4, and CsI, and the major gaseous species are Cs, CsI, and Cs_2I_2. The presence of steam does not alter the species present, although CsOH also becomes a major gaseous species. In a 50% steam—50% air mixture, the condensed phases U_3O_8 or UO_3, $Cs_2U_{15}O_{46}$, and ZrI_3 or liquid ZrI_2 are present at equilibrium, and the gaseous species ZrI_2, ZrI_3, and ZrI_4 have large partial pressures.

26212 (UCID—17695) **Underground pressure suppression system for Boiling Water Reactors (BWRs).** Straume, T. (California Univ., Livermore (USA). Lawrence Livermore Lab.). Jan 1978. Contract W-7405-ENG-48. 8p. Dep. NTIS, PC A02/MF A01.

Large diameter cased holes drilled vertically into geological formations can be used as wet-wells for BWR pressure suppression systems. Such drilling technology is available and is being used in both the mining and underground nuclear testing industries. The cased holes allow for large volumes and great structural strength and can readily accommodate future increases in reactor power levels. It is believed that the vertical vent pipe positioning in the UPSS will decrease the potential for oscillations observed in the $\frac{1}{5}$ scale models of the Mark I. Post-accident radiation decontamination of the UPSS will be faster than presently used designs since dry-well and wet-wells can be cleaned up simultaneously.

26213 Effect of the severe winter upon a cooling pond fog study. Shannon, J.D.; Everett, R.G. (Radiological and Environmental Research Division, Argonne National Laboratory, Argonne, Ill. 60439). *Bull. Am. Meteorol. Soc.;* **59**: No. 1, 60-61(Jan 1978).

The difficulties encountered in an investigation of the fog at the 1200 - acre cooling pond at the nuclear power station in Dresden, Ill. are discussed. (AIP).

26214 Ultrasonic inspection of the spherically shaped perforated areas of light water reactor pressure vessels. Seiger, H. (Krautkraemer G.m.b.H., Koeln (Germany, F.R.)); Engel, G. *NDT Int.;* **10**: No. 6, 293-296(Dec 1977).

The development is described of an ultrasonic system which will test the areas close to the cladded inner surface between the nozzles in the bottom of boiling water reactor pressure vessels and at the top of pressurized water reactor pressure vessels. The technique uses the angle or corner effect in a single probe operation from the outside. A main problem found with this method was the strong backscattering of ultrasonic energy from the austenitic cladding. By varying the frequency, crystal area and angle of incidence used, optimum values for these parameters have been determined for this application.

26215 Kerntechnische Anlagen. Wiederkehrende Pruefungen. Mechanisierte Ultraschallpruefung. Entwurf. (Nuclear facilities. Recurrent inspections. Mechanical ultrasonic inspection. Draft). Berlin, Germany, F.R.; Beuth (Oct 1977). 10p. (In German). (DIN—25435(pt.1)).

This standard applies to recurrent inspections, with mechanical ultrasonic inspection equipment, of the pressure containment of LWR coolant. Directions for methods of inspection, demands to be made on inspection equipment, the procedure of inspection, and documentation are given with the aim to ensure the reliability and comparability of inspections.

26216 Plant engineering experience with primary water purification plants in nuclear power stations with pressurised and boiling water reactors. Wille, H. (Kraftwerk Union A.G., Erlangen (Germany, F.R.)). *VGB Kraftwerkstech.;* **57**: No. 10, 673-679(Oct 1977). (In German).

Ion exchangers are installed for purification purposes on both types of reactor - in ball-form in the case of the PWR and as resin powder deposits in the case of the BWR. An additional dearator is installed in the case of the PWR. With these units during reactor operation both the specified chemical values of the water and also the lowest possible activity levels are adhered to. The paper describes in particular the duties of the water purification systems at start up and shutdown of a reactor as well as the designs and methods of operation of such systems for both reactor types.

26217 GE tackles the nuclear island. Sherwood, G.G.; Sasso, J.R. (General Electric Co., San Jose, Calif. (USA)). *Nucl. Eng. Int.;* **22**: No. 262, 64-66(Sep 1977).

The General Electric Standard Safety Analysis Report (GESSAR) is discussed. This described a standard 1220 MWe BWR/6 nuclear steam supply system, the containment and includes all the structures, systems, equipment and interfaces with the 'nuclear island' so that fewer safety related interfaces need be defined and reviewed. The establishment of pre-approved sites as a method of shortening licensing schedules is discussed. The economic advantages of standardised design, and other benefits such as improved product control and productivity are considered.

26218 Energy from nuclear reactors. Pt. 3. The functioning of nuclear power plants with BWR reactors. Hospe, J. *VDI (Ver. Dtsch. Ing.) Nachr.;* **31**: No. 26, 12(Jul 1977). (In German).

In view of the fact that safety requirements for nuclear power plants have become more rigorous during the last few years, a major target in reactor development has been the establishment of a situation where the licensing procedure will proceed more speedily. The BWR reactor line 72, which has been developed in this context by Kraftwerk Union, will meet these stricter safety requirements in a technically and economically optimal way. It has been fully realized for the first time in Gundremmingen, block B and C.

26219 Energy from nuclear reactors. Water as moderator: LWR reactors prevail. Pt. 1. Hospe, J. *VDI (Ver. Dtsch. Ing.) Nachr.;* **31**: No. 24, 4(Jun 1977). (In German).

This VDI-Nachrichten series has the target to provide a technical-objective basis for the discussion of the pros and cons of nuclear power. The first part deals with LWR-type reactors which so far have prevailed in nuclear power generation.

26220 Coherence analysis of boiling water reactor noise. Fukunishi, K. (Hitachi Ltd., Kawasaki, Kanagawa (Japan). Atomic Energy Research Lab.). *J. Nucl. Sci. Technol. (Tokyo);* **14**: No. 5, 351-358(May 1977).

Empirical studies of coherences between measurement variables from the operating data of a commercial nuclear power station of 460 MWe are applied to derive dynamical characteristics of the Boiling Water Reactor and to attempt to identify the noise sources of the neutron flux. Multivariate techniques with the partial coherence function and the multiple coherence function are introduced to eliminate correlated effects among measurement variables due to thermal hydraulic coupling and sophisticated reactivity feedbacks. From the results, the usual coherency (the ordinary coherence function) may not be adequate to estimate linear relations between measurement variables of the BWR. Furthermore, the noise sources of the neutron flux are discussed.

26221 Phases mission analysis: a review of new developments and an application. Burdick, G.R.; Fussell, J.B.; Rasmuson, D.M.; Wilson, J.R. (EGandG Idaho Inc, Idaho Falls, Idaho). *IEEE Trans. Reliab.;* **R-26**: No. 1, 43-49(Apr 1977).

Both exact and approximate methods for obtaining the unreliability of a nonrepairable system undergoing a phased mission are presented. The techniques are applied to an emergency core cooling system for a boiling water reactor. The estimates for the example agree well with the exact solution. The accuracy and ease of implementation are compared for both methods. The approximation techniques for unavailability estimates for phased missions contained in this paper are useful for industrial applications. 14 refs.

26222 Lingen nuclear power plant: construction and operation. Deublein, O. *Energiewirtsch. Tagesfragen;* **27**: No. 4, 266-268(Apr 1977). (In German).

The Lingen nuclear power plant has been constructed in the years 1964 to 1968 as a so-called demonstration power plant to test the possibility of using nuclear energy for safe and reliable power generation. With a building time of 48 months, construction of the plant was completed in due time. This period included start-up tests and trial operation, which alone took eight months. The nuclear power plant was handed over to the operators on October 1, 1968.

26223 Fuel element assembly. Williamson, H.E.; Smith, B.A. (to General Electric Co., Schenectady, N.Y. (USA)). German(FRG) Patent 2,626,487/A/. 30 Dec 1976. 17p. (In German).

An improvement of the construction of the fuel element assembly of nuclear reactors - especially BWRs - is proposed, where the control of the coolant flow is to be particularly influenced. Between the flow channel and the lower tie plate of the fuel rod cluster a quantity of coolant is branched off (bypass or leakage flow), the amount of which may be controlled by the configuration according to the invention. The lower tie plate has got an opening and a movable part, being supported between the opening and the flow channel and pushed into the flow channel by the coolant pressure thus limiting the leakage flow. For the design of the movable part several variants are given.

26224 Feed water pre-heater with two steam spaces. Tratz, H.; Kelp, F.; Netsch, E. (to Kraftwerk Union A.G., Muelheim an der Ruhr (Germany, F.R.)). German(FRG) Patent 2,458,474/C/. 9 Dec 1976. 3p. (In German).

A feed water pre-heater for the two stage heating of feed water by condensing steam, having a low installed height is described, which can be installed in the steam ducts of turbines of large output, as in LWRs in nuclear power stations. The inner steam space is closed on one side by the water vessel, while the tubes of the inner steam space go straight from the water vessel, and the tubes of the outer steam space are bent into a U shape and open out into the water vessel. The two-stage preheater is thus surrounded by feedwater in two ways.

26225 Nuclear reactor. Ashcroft, D.J.; Timbs, A.E.; Blake, G.; Rigg, S.; Brocklebank, R.B. (to UKAEA London Office). German(FRG) Patent 1,614,939/B/. 9 Dec 1976. 13p. (In German).

The design of a LWR, where reactor core and heat exchangers are enclosed by a metal pressure vessel, is to be improved. The metallic pressure vessel has an upper closure head and a ring which is located sealed between the pressure housing and the closure head and which carries the heat exchangers and (supported) the reactor core. In order to avoid stresses in the reactor wall, the penetrations to the heat exchangers are to be passed through the ring. 6 drawings explain the types of design proposed for it.

26226 Method to prolong the fuel cycle in a boiling water reactor. Mattern, J. (to Licentia Patent-Verwaltungs-G.m.b.H., Frankfurt am Main (Germany, F.R.)). German(FRG) Patent 1,614,047/C/. 6 May 1976. 1p. (In German).

According to the invention, the fuel cycle can be prolonged in a boiling water reactor at the end of the projected fuel cycle, i.e. after all control rods have been withdrawn, maintaining the rated power, by reducing the steam bubble content of the water used as moderator by lowering the feedwater temperature.

POWER REACTORS, NON-BREEDING, LIGHT-WATER MODERATED, NON-BOILING WATER COOLED

REFER ALSO TO CITATION(S) 26190, 26209, 26210, 26211, 26224, 26225, 26305, 26339, 26433, 26440, 26443, 26445, 26458, 26462, 26479

26227 (CONF-771109—90) **Containment for small pressurized water reactors.** Siler, W.C.; Marda, R.S.; Smith, W.R. (Babcock and Wilcox Co., Lynchburg, Va. (USA)). 1977. Contract W-7405-ENG-26. 6p. NTIS, MF A01.

From ANS winter meeting; San Francisco, CA, USA (27 Nov 1977).

Portions of document are illegible.

Babcock and Wilcox Company has prepared studies under ERDA contract of small and intermediate size (313, 365 and 1200 MWt) PWR reactor plants, for industrial cogeneration or electric power generation. Studies and experience with nuclear plants in this size range indicate unfavorable economics. To offset this disadvantage, modular characteristics of an integral reactor and close-coupled vapor suppression containment have been exploited to shorten construction schedules and reduce construction costs. The resulting compact reactor/containment complex is illustrated. Economic studies to date indicate that the containment design and the innovative construction techniques developed to shorten erection schedules have been important factors in reducing estimated project costs, thus potentially making such smaller plants competetive with competing energy sources.

26228 (LTR—10-2B) **Hybrid computer simulation of the LOFT plant.** Konya, M.J.; Feeley, J.J.; Hyer, F.K. (SEE CODE- 9502158 EG and G Idaho, Inc., Idaho Falls (USA). Idaho National Engineering Lab.). 29 Aug 1977. Contract EY-76-C-07-1570. 119p. (RE-P—77-069). Dep. NTIS, PC A06/MF A01.

A real-time hybrid computer simulation of the LOFT facility has been developed to predict dynamic plant response to both normal and abnormal operating conditions. The report contains a detailed description of the analytical basis for the LOFT plant simulation. The current simulation contains the following plant components: reactor core, vessel, primary coolant loop, pressurizer, PPS, steam generator, air-cooled condenser, condensate receiver, feedwater subcooler, steam generator water level control system and air-cooled condenser pressure control system. These individual component models are functionally integrated on an Applied Dynamics System 511 hybrid computer to form the total plant simulation. The LOFT plant simulation has been recently used to analyze plant response to a variety of postulated accidents for the LOFT FSAR. Future tasks requiring use of the simulation include verification of zero power physics test procedures, analysis of plant maneuvering procedures and continued operator training.

26229 Chemical process measurements in PWR-type nuclear power plants. Glaeser, E. (VEB Kernkraftwerk Bruno Leuschner, Greifswald (German Democratic Republic). Betriebsteil Kernkraftwerk Rheinsberg). *Kernenergie;* **21**: No. 2, 37-41(Feb 1978). (In German).

From 3. CMEA symposium on water treatment and problems of fuel element monitoring in nuclear power plants; Neubrandenburg, German Democratic Republic (2 - 5 Nov 1976).

In order to achieve high levels of availability of nuclear power plants equipped with pressurized water reactors, strict standards have to be applied to the purity of coolant and of other media. Chemical process measurements can meet these requirements only if programmes are established giving maximum information with minimum expenditure and if these programmes are realized with effective analytical methods. Analysis programmes known from literature are proved for their usefulness, and hints are given for establishing rational programmes. Analytical techniques are compared with each other taking into consideration both methods which have already been introduced into nuclear power plant practice and methods not yet generally used in practice, such as atomic absorption spectrophotometry, gas chromatography, etc. Finally, based on the state of the art of chemical process measurements in nuclear power plants, the trends of future development are pointed out.

26230 Studies on space dependence of the spectral density functions of neutron flux noise in pressurized water reactors. Gaertner, K.; Kraus, W. (Ingenieurhochschule Zittau (German Democratic Republic). Sektion Kraftwerksanlagenbau und Energieumwandlung). *Kernenergie;* **21**: No. 2, 56-59(Feb 1978). (In German).

The propagation in space of neutron flux fluctuations in a pressurized water reactor induced by fluctuations of coolant entrance temperature has been investigated using the spectral density functions. For this purpose a set of dynamical equations has been derived taking into account the temperature feedback effects. This set has been evaluated in some different approaches. The numerical results obtained have been used to discuss the possibility of applying the point model or the model of global and local effects.

26231 Effects on the activity level in the primary circuit water coolant of pressurized water reactors by continuous purification of partial streams. Bosholm, J. (Ingenieurhochschule Zittau (German Democratic Republic). Sektion Kraftwerksanlagenbau und Energieumwandlung); Lafery, H. (VEB Kernkraftwerk Bruno Leuschner, Greifswald (German Democratic Republic)). *Kernenergie;* **21**: No. 2, 42-45(Feb 1978). (In German).

From 3. CMEA symposium on water treatment and problems of fuel element monitoring in nuclear power plants; Neubrandenburg, German Democratic Republic (2 - 5 Nov 1976).

Calculations of the effects of a continuously working purification plant on the activity level of dissolved radionuclides have been performed and verified by measurements in a nuclear power plant. When conventional flow rates of about 10% of a primary circuit volume per hour are applied in such plants, online decrease of the activity level could be observed for long-lived radionuclides only. The effect on a mixture of radionuclides containing short-lived emitters is low. However, an essential decrease of the activity level by use of purification plants is possible when the reactor is shut down.

26232 World's reactor, No. 72. Cherokee/Perkins Nuclear Stations. *Nucl. Eng. Int.;* **22**: No. 265, 45(Dec 1977).

A coloured wall-chart is presented which shows a sectionalised drawing of the Cherokee/Perkins nuclear stations. Main parameters are listed.

26233 System 80 NSSS combines proven and new features. Bevilacqua, F. *Nucl. Eng. Int.;* **22**: No. 265, 39-44(Dec 1977).

The Combustion Engineering System 80 NSSS will be used in Cherokee I and in subsequent Cherokee and Perkins units. It has a larger core to meet conservatively the NRC limit of 3800 MWth, an improved steam generator and a new low kW/ft fuel assembly to ensure satisfaction of the new ECCS criteria and minimize densification effects. Other changes cover improved control, instrumentation and protection and faster refuelling.

26234 Back pressure: tight main steam isolating valves for PWRs. Grotloh, Kh. (Gebrueder Sulzer, Aktiengesellschaft, Winterhur). *Nucl. Eng. Int.;* **22**: No. 265, 55-59(Dec 1977).

In nuclear steam supply systems quick closing valves are needed to isolate the main steam line to the turbine; they are a part of the reactor containment. System medium operated isolating valves developed by Sulzer are used in many BWRs. A valve for PWR application based on the principle of system medium operation has also been designed. The reasons for using this principle and the added requirements arising from their application in PWR plants are presented.

26235 Standardization facilitated by Duke's in-house capability for design and construction. Mathews, T.A. *Nucl. Eng. Int.;* **22**: No. 265, 37-39(Dec 1977).

In the building of the six identical 1280 MWe units at Cherokee and Perkins the in-house engineering departments of Duke Power will be responsible for the design, construction, testing, start-up and operation. Ease of communication will make standardization easier. Among several innovative design techniques are the use of computers for the production of drawings and continuous cost estimation. The engineering organisation is briefly outlined. Standardization has also simplified the process of obtaining a licensing application, the procedures for which are described.

26236 C-E balances the benefits against the costs. Bevilacqua, F.; Higgins, W.H. (Combustion Engineering, Inc., Windsor, Conn. (USA)). *Nucl. Eng. Int.;* **22**: No. 262, 59-62(Sep 1977).

The Combustion Engineering philosophy on design standardisation for nuclear power plants, and developments resulting in the 3800 MWt, System 80 standard design are outlined. Specific changes made to previous designs are indicated. For practical reasons something less than complete standardisation had to be accepted. The success of the effort, shown by the measure of acceptance by the four utilities for which System 80 is being designed and built, is categorised and explained for various design features and components. Licensing procedures are discussed. A proper return on the high initial cost of introducing standard systems will only be achieved when changes in the licensing process reduce the total project span time.

26237 KWU puts the emphasis on planning and control. Gehring, W. (Kraftwerk Union A.G., Erlangen (Germany, F.R.)). *Nucl. Eng. Int.;* **22**: No. 262, 66-68(Sep 1977).

The importance of setting up an authoritative centralised department to plan, direct, and control standardisation policy for PWR type reactors and to ensure a proper flow of information was recognised by Kraftwerk Union at an early stage. The benefits and requirements of standardisation are discussed and the role of the KWU standardisation department in project bidding and implemen-

tation is illustrated. The Technical Proposal for a Standard turnkey PWR, which comprises eleven volumes, and the development of a Standard Operation Manual are both discussed.

26238 Novel design for PWR pressure vessels. Martin, A.; Widart, J.; Scailteur, A. (Cockerill S A, Seraing (Belgium)). *Nucl. Eng. Int.;* **22**: No. 262, 74-75(Sep 1977).

A novel design is described for PWR pressure vessels which allows reduction in the number of welded joints and adoption of joint geometries and is particularly favourable for manufacturing and inservice inspection. The 'Integral Vessel Design' has already been adopted for the latest two Belgian nuclear power plants (3 loop vessels). It confers to the reactor vessels significant advantages in mechanical behaviour, manufacturing and inservice inspection.

26239 Irreversible process for Framatome. Metais, J.L. (Societe Franco-Americaine de Constructions Atomiques (FRAMATOME), 92 - Courbevoie (France)). *Nucl. Eng. Int.;* **22**: No. 262, 62-64(Sep 1977).

France has at present 26 virtually identical PWR units in operation or under construction. The advantages of standardisation are described. The high degree of standardisation in the French nuclear programme is seen as an important factor in the rapid development of Framatome and in its successful export achievements.

26240 Progress report on the SNUPPS nuclear stations. Petrick, N.A. *Nucl. Eng. Int.;* **22**: No. 262, 55-57(Sep 1977).

The concept of SNUPPS, the Standardised Unit Power Plant System evolved in 1973 when five US utilities agreed to build standardised nuclear plants to one common design. An assessment is made of the progress made in realising the objectives of the operation from the aspects of design engineering, licensing, supply of materials and equipment, construction, and operating procedures.

26241 Koeberg's cooling water marine basin next on agenda. Purvis, G. *Nucl. Eng. Int.;* **22**: No. 262, 47-48(Sep 1977).

The first nuclear power plant on the African continent will be South Africa's Koeberg plant which is to consist of two 922 MW PWR units. The plant is based on the French plant Tricastin but varies in its use of sea-water for cooling and its design solution for seismic effects. Brief details are given of the organisations involved, financing, and site development.

26242 Westinghouse seeks minimum costs with maximum reliability. Scheetz, E.J.; Meoli, D.D. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA)). *Nucl. Eng. Int.;* **22**: No. 262, 57-59(Sep 1977).

The development and present status of Westinghouse standardisation procedures for ensuring minimum costs and maximum reliability for nuclear power components are discussed. In particular, the functions of two documents are described. The Standard Information Package was developed to meet the need for immediate flow of information between the NSSS vendor and the architect-engineer. The concept of a Reference Safety Analysis Report was developed in 1960, and is a method of updating licensing documentation. The revised RESAR-3S is referenced as part of the Preliminary Safety Analysis Report for construction permit applications and its use realises considerable saving in licensing time.

26243 Recommendations of the Reactor Safety Commission during its 121st meeting on February 16th, 1977. Kernkraftwerk Hamm (KKH). Site and safety concept. *Bundesanzeiger;* **29**: No. 124, 2-4(Jul 1977). (In German).

On the basis of the RSC's consulation results concerning site and safety concept, and on the basis of the results of the Radiation Protection Commission (SSK) concerning the radiation exposure of the population, the Ministry of the Interior is advised to consent to the erection of the nuclear power plant.

26244 Energy from nuclear reactors. Pt. 2. The functioning of nuclear power plants with PWR reactors. Hospe, J. *VDI (Ver. Dtsch. Ing.) Nachr.;* **31**: No. 25, 13-14(Jun 1977). (In German).

This second part of the series on nuclear reactors deals with the functioning of PWR-type reactors. Reactors of this type are installed, e.g., in the Biblis and Unterweser nuclear power plants.

26245 Muelheim—Kaerlich nuclear power plant. Gutmann, H. *Energiewirtsch. Tagesfragen;* **27**: No. 4, 263-265(Apr 1977). (In German).

This report on the Muelheim-Kaerlich nuclear power plant does not give a detailed technical description, since work of this kind has already been published earlier. The present report deals with the procedure until the commencement of building, some marginal aspects, and with the differences between this plant and other well-known plants.

26246 Boiler. Reisacher, R. (to Kraftwerk Union A.G., Muelheim an der Ruhr (Germany, F.R.)). German(FRG) Patent 2,358,829/C/. 13 Jan 1977. 4p. (In German).

The flow conditions of a boiler for a PWR, where the primary medium is carried in a bundle of U-shaped tubes, are to be improved without increasing the flow resistance. According to the invention this can be achieved by providing in a tube path enclosed in the bundle of tubes, a channel narrowing towards the floor, and by taking parts of the feed water from the outer space through throttles into the narrow end of the channel. Some variations of constructive arrangement are described.

26247 Changes in pressurized water reactor group constants caused by burnup and the role of fuel nuclides. Penndorf, K.; Schult, F. (Gesellschaft fuer Kernenergieverwertung in Schiffbau und Schiffahrt m.b.H., Geesthacht-Tesperhude (Germany, F.R.)). *Atomkernenergie;* **30**: No. 3, 192-206(1977). (In German).

It was the aim to find out a simple way for describing the influence of burnup on the group constants within the framework of whole-core calculations of the PWR taking into account the simultaneous coupling of burnup, local power, and control poison. In order to assure considering of essential features only it was deemed necessary to analyze the neutron spectra and the physical assumptions made for their generation. This analysis leads to favoured observation of the thermalization domain and points at the outstanding role of the plutonium isotopes Pu239, Pu240, and Pu241.

26248 Commissioning of a nuclear power plant. Broch, M.; Cayol, D. (Electricite de France, 92 - Clamart. Region d'Equipement). *Rev. Gen. Nucl.;* No. 3, 212-220(1977). (In French).

The commissioning tests of a nuclear power plant which allow checking of the quality of a plant, as constructed, is one of the guarantees to dispose of a plant which offers maximum reliability and availability. After having presented the different types of tests and their staging in time, it is explained how they have been prepared, programmed and put into application. The theoretical contents of the test programme established for nuclear power stations is then analyzed its practical application to Phase no.2 of the Fessenheim Power Station is described.

26249 Radioanalysis of water circuit at nuclear power plants. Bereznai, T.; Bodizs, D.; Csom, Gy.; Desi, S.; Gyurkocza, Cs.; Keoemley, G.; Molnar, Zs. (Budapesti Muszaki Egyetem (Hungary). Egyetemi Reaktor). *Energ. Atomtech.;* **30**: No. 1, 38-44(1977). (In Hungarian).

Methods of determining gamma-emitting radioactive isotopes accumulating in the heat-transfer agent of VVER type nuclear power plants are described. The sources of nuclides accumulating in the heat-transfer agent are presented and analyzed. The measurement of the radioactive concentration of the agent and the design of the measuring system are discussed.

26250 Optimal power profile fuel management. Chen, Y.F.; Mingle, J.O.; Eckhoff, N.D. (Kansas State Univ., Manhattan (USA). Dept. of Nuclear Engineering). *Ann. Nucl. Energy;* **5**: No. 9, 407-415(1977).

A method has been developed to determine a refueling pattern for light water reactors for the purpose of minimizing the radial power peaking ratio. The key points of this method are (1) the highest reactivity fuel assemblies are always placed into the peripheral region of the reactor, (2) the remainder of the assemblies are divided into two groups based on their neutronic characteristics, and are loaded into the reactor in a checkerboard pattern and (3) a loading priority sequence is generated for each group. To insure uniformity of the fuel distribution, linear programming is used for placement of the assemblies. The method is not limited by dimensional difficulties and is easily adaptable to an individual utility's current practices. Results show that this method is capable of consistently producing a satisfactory loading pattern under various refueling policies.

26251 Second partial licence for the erection of a nuclear power plant within the boundaries of Muelheim-Kaerlich dated 6th July 1977. *Staerke;* No. 28, 503-504(1977). (In German).

License for the whole complex of buildings, erection of the substructures of various reactor buildings and auxiliary buildings and the natural-draught cooling tower.

26252 Burst protection for containers under high pressure, in particular steam generators. Daublebsky, P. German(FRG) Patent 2,522,214/A/. 2 Dec 1976. 9p. (In German).

An improved burst protection for containers under high pressure, e.g. steam generators of PWR reactors, is described which allow certain parts of the pressure vessel to be entered, e.g. for inspections. According to the invention, the chambers are axially spaced, the courses are provided with axial slots over their whole length at one or several points, and there is at least one restraint to press the courses against the chambers. Then, after the restraint has been unfastened, the chambers may be axially moved.

26253 Pressurized-water reactor. Schabert, H.P.; Helf, H. (to Kraftwerk Union A.G., Muelheim an der Ruhr (Germany, F.R.)). German(FRG) Patent 2,430,725/A/. 15 Jan 1976. 17p. (In German).

To improve the safety of a PWR reactor, it is proposed to install a second line parallel to the live steam line leading out of the containment. The cross section of this second line is reduced by 50%, and both lines have isolating valves inside the containment. Further constructional details are described.

POWER REACTORS, NON-BREEDING, GRAPHITE MODERATED

REFER ALSO TO CITATION(S) 26338, 26407, 26410, 26434, 26467

26254 (GA-A—14034) **COPAR, a program to compute release of metallic fission products from coated particles.** Smith, P.D.; Steinke, R.G. (General Atomic Co., San Diego, Calif. (USA)). Nov 1977. Contract EY-76-C-03-0167-017. 153p. NTIS, MF A01.

A model is presented which simulates the release of metallic fission products from coated fuel particles. The model is based on a solution of the transient Fickian diffusion equation in a non-homogeneous medium. A highly efficient numerical evaluation enables the model to be used as a source subroutine in full core release problems. There are a number of physical parameters in the model that give it versatility in correlating and extrapolating experimental results. The coated particle model has been programmed as a series of computer programs having the generic name COPAR. COPAR/STAL is a stand-alone program for the analysis of a single particle with a unit birth pulse imposed as an initial condition. TABLE/REL is a modular subroutine, similar to COPAR/STAL, which calculates tabulated non-dimensional release functions. These functions are evaluated for several particle types (e.g., BISO and TRISO) in both the intact and the failed states. Finally, PART/REL is a modular subroutine for calculating the time-dependent release from a collection of particles with a continuous history of temperature, fission birth, and failure fraction. This is done by the superposition of numerous birth-pulse solutions, all of which are evaluated by linear interpolation in the predefined tables. The report is a user's manual for this series of codes. Included are an explanation of the theory, a discussion of the program organization, the input instructions, and a set of sample problems.

26255 (ORNL/NUREG/TM—164) **High-temperature gas-cooled reactor safety studies for the Division of Reactor Safety Research. Quarterly progress report, July 1—September 30, 1977.** Ball, S.J.; Cleveland, J.C.; Hatta, M.; Conklin, J.C.; Sanders, J.P. (Oak Ridge National Lab., Tenn. (USA)). 16 Dec 1977. Contract W-7405-ENG-26. 25p. Dep. NTIS, PC A02/MF A01.

HTGR safety studies work this quarter included further investigations of postulated Fort St. Vrain (FSV) rod withdrawal accidents and a calculation of an FSV scram from 25% power to compare with test data. General Atomic Company's (GAC's) TAP and RECA programs were evaluated, and a draft report on the evaluation was completed.

26256 Advanced gas-cooled reactor has good energy prospects. Bainbridge, G.R. (Newcastle upon Tyne Univ. (UK)); Hryniszak, W. *Electr. Rev. (London);* **201**: No. 14, 32-34(7 Oct 1977).

The status and future prospects for Britain's AGR type reactors are reviewed. The successful, if delayed, operation of the AGR power stations shows that their design could be developed for export and that improved performance is possible. Also gas-cooled reactor experience gained, points the way to future high-temperature gas-cooled designs which could provide process heat, or power gas turbines and combined cycle stations.

26257 Hot spots in active packed beds. Buchlin, J.M.; Lapthorn, J.C.; Ginoux, J.J. (Institut von Karman de Dynamique des Fluides, Rhode-St. Genese (Belgium)). *Verfahrenstechnik (Mainz);* **11**: No. 10, 620-624(Oct 1977).

From Meeting on heat transfer; Petten, Netherlands (Sep 1975).

The present paper studies the formation of hot spots in a packed bed of active equal-sized spheres with emphasis on the design of gas cooled thermal reactors using fuel assemblies of coated particles. It is found experimentally that the presence of hot spots is a consequence of the voidage distribution of the random packing. It is confirmed by a theoretical approach based on a deterministic/continuum two-phase model. The theory also enables to emphasize the important role of the mean flow distribution at the inlet of the bed and of the wall heat transfer conditions on the 'hot spot' phenomenon.

26258 Birth of Calder Hall. Lord Hinton of Bankside. *Atom (London);* No. 252, 249-253(Oct 1977).

Personal and technical reminiscences by Lord Hinton on the occasion of the 21st anniversary of the opening of the Calder Hall nuclear power station by H.M. the Queen. This was the first nuclear power station in the world to produce electricity on a commercial scale.

26259 Layout of the reactor cores of gas-cooled HTR-type reactors. Pt. 1. Calculation of the physical characteristics of helium. Draft. Koeln, Germany, F.R.; Heymanns (Oct 1977). 22p. (In German). (KTA—3102.1).

This draft regulation applies to the following physical characteristics of helium: Density, specific heat, dynamic viscosity, and thermal conductivity. It gives the equations for the calculation of these physical characteristics, including the standard deviation.

26260 Energy from nuclear reactors. Pt. 8. Two coal gasification procedures using reactor heat - 70% conversion efficiency. Hospe, J. *VDI (Ver. Dtsch. Ing.) Nachr.;* **31**: No. 31, 2(Aug 1977). (In German).

The heat generated in the HTR reactors may be used directly for coal gasification into methane or synthesis gas, for the catalytic cracking of methane, for the supply of high-temperature heat for the industry, and for thermal water splitting.

26261 Refuelling system for a nuclear reactor with a reactor core showing (presenting) a pebble bed of spherical fuel elements. Valette, L. (to Hochtemperatur-Reaktorbau G.m.b.H., Koeln (Germany, F.R.)). German(FRG) Patent 1,764,924/C/. 16 Jun 1977. 2p. (In German).

A facility is proposed which allows to sort out fuel elements with defects, releasing large amounts of fission products, from the refuelling cycle of a pebble bed reactor. According to the invention, between the charging and the discharging tube a furnace is arranged heating up again the cooled-down elements to reactor operational temperatures, thereby possibly releasing fission products. A measuring chamber permits detection of the failed elements which then may be removed.

26262 Pebble bed reactor with one-zone core. Mueller-Frank, U.; Lohnert, G. (to Gesellschaft fuer Hochtemperaturreaktor-Technik m.b.H., Bergisch Gladbach (Germany, F.R.)). German(FRG) Patent 2,545,013/A/. 14 Apr 1977. 11p. (In German).

The claim deals with measures to differentiate the flow rate and to remove spherical fuel elements in the core of a pebble bed reactor. Hence the vertical rate of the fuel elements in the border region is for example twice as much as in the centre. A central funnel-shaped outlet on the floor of the core container over which a conical body is placed with its peak pointing upwards, or also the forming of several outlets can be used to adjust to a certain exit rate for the fuel elements. The main target of the invention is a radially extensively constant coolant outlet temperature at the outlet of the core which determines the effectiveness of the connected heat exchanger and thus contributes to economy.

26263 Dry cooling towers: the Schmehausen example. Weber, P. *Energie;* **29**: No. 4, 113-114(Apr 1977). (In German).

In a prototype, there are often problems which require special static, constructive, and assembling measures for their solution. In the case of the Schmehausen dry cooling tower, the demands on the assembling technology are particularly high.

26264 Pyrocarbon-coated fuel particles for fuel elements of HTR reactors. Hackstein, K.; Schmitten, W. (to Nuklear-Chemie und -Metallurgie G.m.b.H. (NUKEM), Hanau (Germany, F.R.)). German(FRG) Patent 1,927,866/C/. 27 Jan 1977. 2p. (In German).

The invention deals with fuel particles for HTR fuel elements with a core of heavy metal carbides or oxides, which are coated with layers of pyrolytic carbon. The pyrolytic carbon coating consists of a number of alternating porous and ligh-density layers. This arrangement will retain fission gases as well as solid fission products and heavy metals. According to the invention, the innermost high-density layer is isotropic and the other high-density layers, which are 20-50 μm thick, are anisotropic and retain the solid fission products.

26265 Measurement techniques for AGR circulators in a full-density rig. Watson, I.; Wilson, R.R. (James Howden and Co. Ltd., Glasgow). pp 65-79 of Operation of instruments in adverse environments, 1976. Knight, J. (ed.). London; Institute of Physics (1977).

From Conference on the operation of instruments in adverse environments; London, UK (4 Oct 1976).

See CONF-7610120—.

Safety and reliability are important factors of a nuclear power plant. This applies in particular to the circulators used to drive the high-density CO_2 around the reactor core and boiler circuits. Under operating conditions, very high sound-pressure levels are generated which could excite components and cause possible fatigue failures. Failures of this type were experienced on the original axial blowers for the Hinkley "A" Magnox reactor and, following this, a stringent test plan was specified for the AGR circulators. The paper describes some of the techniques used to measure strain, sound and vibration on circulators in a full-density rig. This rig reproduces the actual reactor working conditions of 300°C and 4.1 MN m^{-2} with gas velocities up to 120 m s^{-1}. Under these conditions sound-pressure levels of up to 172 db are generated. This program of circulator testing has continued for the past 10 years. During this period many

obstacles and difficulties were encountered. Some of these problems, together with the solutions found, are discussed.

26266 Reactor core consisting of a number of interspersed groups of identical columns. Rennie, C.A.; Lockett, G.E.; Hosegood, S.B. (to Commission of the European Communities, Brussels (Belgium)). German(FRG) Patent 1,817,079/B/. 2 Dec 1976. 8p. (In German).

The construction of a reactor core consisting of a group of identical columns made of moderator material is described, the groups forming a block. According to the invention, there is to be a certain clearance between the surfaces of adjoining blocks which makes easy removal of the individual blocks possible.

26267 Refuelling system for a nuclear reactor with a reactor core exhibiting a pebble bed of spherical fuel elements. Valette, L. (to Hochtemperatur-Reaktorbau G.m.b.H., Koeln (Germany, F.R.)). German(FRG) Patent 1,764,924. 11 Nov 1976. 2p. (In German).

A facility is proposed which allows to sort out fuel particles with defective coatings, releasing large amounts of fission products, from the refuelling cycle of a pebble bed reactor. According to the invention, between the charging and the discharging tube a furnace is arranged heating up again the cooled-down particles to reactor operational temperatures, thereby possibly releasing fission products. A measuring chamber permits detection of the failed elements which then may be removed.

26268 Heat exchanger designed as longitudinal counter flow equipment. Ecker, H. (to Hochtemperatur-Reaktorbau G.m.b.H., Koeln (Germany, F.R.)). German(FRG) Patent 2,517,693/A/. 4 Nov 1976. 23p. (In German).

An improvement for heat exchangers is described, which should make them suitable for use in a closed gas turbine cycle or in the primary loop of a gas-cooled high-temperature reactor with a helium turbine, as they have a small volume. It is proposed that the bundles of tubes should be divided into separate boxes, which are arranged in a hexagonal grid; the return pipes are arranged in a sheath in the centre of this grid and are welded to the cover of this. The subdivision into separate boxes makes maintenance easier. Constructional details are given, and there are 9 drawings.

26269 Method for the coating of particles with single layers of pyrolytic carbon having different densities. Schwartz, A.S. (to Hochtemperatur-Reaktor-Brennelement G.m.b.H. (HOBEG), Hanau (Germany, F.R.)). German(FRG) Patent 1,902,344/C/. 21 Oct 1976. 5p. (In German).

The patent claims an improvement of the fluidized-bed method for the coating of particles with multiple pyrolytic carbon layers of different thickness. The coated particles are used as fuels in nuclear engineering. The process can be carried out in a single coating plant. Different physical properties of the layers are obtained by changing the hydrocarbons which are thermally decomposed. When using propane or butane at relatively low temperatures, a thick isotropic layer of pyrolytic carbon is produced (Bacon anisotropy factor 1.2). A layer with higher porosity is obtained by lowering the temperature and changing the hydrocarbon.

26270 Method and device for coating of particles, containing fissile, fertile or absorber material, used for HTR fuel elements. Huschka, H.; Warzawa, W. (to Hochtemperatur-Reaktor-Brennelement G.m.b.H. (HOBEG), Hanau (Germany, F.R.)). German(FRG) Patent 2,343,123/B/. 23 Sep 1976. 5p. (In German).

In order to achieve even burn-up of the coated particles of nuclear breeder materials or fuels in a fluidised bed for fuel elements of high-temperature nuclear reactors, it is proposed that coating gas (carbohydrates, silane) should be blown through the nozzles from above (opposed to the flow of carrier gas) at a higher velocity than the carrier gas producing the turbulence. Sub-pressure (760 Torr) can be used to advantage, and controls the particle movement through different crossections of the gas inlet openings. The plant described is hardly prone to failure, is simple to operate and can be built into hot cells. The coating of the particles is very even.

POWER REACTORS, NON-BREEDING, OTHERWISE MODERATED OR UNMODERATED

REFER ALSO TO CITATION(S) 26463

26271 Non-rotating device for in-situ inspection of pressure tube in CANDU nuclear reactors. Coote, R.I. (Atomic Energy of Canada Ltd., Chalk River, Ontario. Chalk River Nuclear Labs.). *Br. J. Non-Destr. Test.;* **20**: No. 1, 21-24(Jan 1978).

From 8. world conference on non-destructive testing; Cannes, France (Sep 1976).

A system capable of volumetric inspection of the pressure tube wall along its full length is described. Plate waves propagating in a circumferential direction eliminate the need for rotational movement.

26272 Electrical design aspects for nuclear power plants. Malhotra, S. *J. Inst. Eng. (India), Electr. Eng. Div.;* **57**: No. L5, 218-224(Apr 1977).

Salinet design features of the electrical system of nuclear power plants specifically covering natural uranium fuelled, heavy water moderated, pressurized heavy water cooled power plants are discussed. Some of the aspects covered for these commonly accepted commercial power plants are valid for conventional plants also. Reliability problems of the electrical components which are the foremost criteria of the nuclear power plants has been dealt with in detail.

26273 Wet steam turbines for nuclear generating stations -design and operating experience. Usher, J. (Parsons (C.A.) and Co. Ltd., Newcastle upon Tyne (UK)). *J. Inst. Nucl. Eng.;* **18**: No. 5, 141-146(1977).

Lecture to the Institution of Nuclear Engineers, 11 Jan. 1977. The object of this lecture was to give an account of some design features of large wet steam turbines and to show by describing some recent operational experience how their design concepts were fulfilled. Headings are as follows: effects of wet steam cycle on turbine layout and operation (H.P. turbine, L.P. turbine); turbine control and operation; water separators; and steam reheaters.

POWER REACTORS, BREEDING

REFER ALSO TO CITATION(S) 26405, 26431, 26432, 26439, 26442, 26475, 26476, 26477, 26599, 26633, 26634, 26635, 26641

26274 (AI-DOE—13208) **Sodium technology and cover gas seal development programs. Quarterly technical progress report, July—September 1977.** (Atomics International Div., Canoga Park, Calif. (USA)). 10 Nov 1977. Contract EY-76-C-03-0824. 64p. .

Progress is summarized in studies related to LMFBR-FFTF cover gas seals development and testing and in sodium removal and decontamination of LMFBR components. (DG)

26275 (AI-DOE—13211) **Sodium-to-gas leak detection. Annual technical progress report, government fiscal year 1977.** (Atomics International Div., Canoga Park, Calif. (USA)). 18 Nov 1977. Contract EY-76-C-03-0824-012. 12p. .

The objectives of the program are to: (1) demonstrate the sensitivity, reliability and operability of liquid metal-to-gas leak detection instrumentation, and (2) provide information that can be used to establish criteria to guide the design of detection systems for use in LMFBR plants. During the report period, this project continued to provide data that are of use to the Clinch River Breeder Reactor Plant (CRBRP), Fast flux Test Facility (FFTF) and the American Society of Mechanical Engineers (ASME) working group on inservice inspection. These data were derived from: (1) small insulated pipe (test chamber atmosphere natural circulation) sodium leak tests, and (2) long-term performance tests of aerosol detectors at EBR-II. Preparations were made for tests to verify the performance of selected aerosol detectors in simulated LMFBR environments. Testing was postponed in deference to urgent experimental efforts essential to FFTF leak detection system design.

26276 (AI-DOE—13216) **Evaluations of the piping system inelastic analysis computer program PIRAX2.** Rodabaugh, E.C. (Atomics International Div., Canoga Park, Calif. (USA)). 24 Oct 1977. Contract EY-76-C-03-0824. 75p. Dep. NTIS, PC A04/MF A01.

The report contains two sets of comparisons of inelastic test data with PIRAX2-Theory; i.e., ORNL beam tests and ORNL elbow tests. The purpose of these comparisons is to evaluate the accuracy of the simplified analytical techniques used in PIRAX2. The test data are on structures that are much simpler than piping systems but provide a fundamental basis for comparison. The report includes an analysis of a 3-anchor piping system to illustrate the relative simplicity of PIRAX2 input/output data and relatively small computer running time. Some areas of needed improvements in PIRAX2 are discussed.

26277 (ANL—77-20) **Bubble dynamics in a superheated liquid.** Sha, W.T.; Shah, V.L. (Argonne National Lab., Ill. (USA)). Sep 1977. Contract W-31-109-ENG-38. 55p. (NUREG—0333). Dep. NTIS, PC A04/MF A01.

The report presents an extensive literature survey on bubble dynamics. Growth of a single spherical bubble moving in a uniformly superheated liquid is considered. Equations of motion and energy are presented in the forms that take into consideration the interaction between the motion and the growth. The fourth-order Runge-Kutta method is used to obtain a simultaneous solution of equations of motion and growth rate, and the solution is compared with available experimental results. Results for liquid sodium are presented for a range of pressures and Jakob numbers.

26278 (ANL-CT—78-9) **Sodium flow calibration using a pulsed neutron activation technique on a 400mm (16 inch) pipe at LMEC.** Forster, G.A.; Kehler, P. (Argonne National Lab., Ill. (USA)). Nov 1977. Contract W-31-109-ENG-38. 33p. .

The velocity of liquid sodium in pipes can be measured by the pulsed neutron activation (PNA) technique without disturbing the pipe or removing insulation. A collimated beam of 14 MeV neutrons is directed against the sodium filled pipe. The resulting gamma activity is detected a suitable distance downstream. The velocity is determined from the spacing of source and detector, and the transit time of the activated sodium weighted for gamma decay. Data were taken on the 400 mm sodium system at LMEC at temperatures of 200, 400, and 560°C. The resulting velocities come within the 2 percent predicted uncertainty limit for the higher flow ranges when compared to the system's Venturi reference flowmeter. A low velocity measuring capability (.05 m/s) was also demonstrated.

26279 (COO—2245-35TR) **Analysis of the feasibility of implementing an implicit temporal differencing scheme in the SUPERENERGY code.** Masterson, R.; Todreas, N. (Massachusetts Inst. of Tech., Cambridge (USA). Dept. of Nuclear Engineering). Feb 1977. Contract EY-76-S-02-2245. 34p. Dep. NTIS, PC A03/MF A01.

In order to assess the optimum approach for extending the SUPERENERGY code to transient LMFBR analysis, it is necessary to consider the advantages and disadvantages of the various temporal differencing schemes that can be applied to the energy equation used by the code. These differencing schemes can be fully implicit or fully explicit, although differencing schemes consisting of a combination of temporally implicit and explicit parts may also be used. It is well recognized that temporally implicit differencing schemes tend to be more stable, but that this stability can be offset in practice by factors such as greater computer storage requirements and considerably longer running times.

26280 (COO—2245-37TR) **Approximate method for predicting temperature distribution in wire wrapped fuel assemblies of a LMFBR.** Mikic, B.; Khan, E.U.; Todreas, N.E. (Massachusetts Inst. of Tech., Cambridge (USA). Dept. of Nuclear Engineering). Apr 1977. Contract EY-76-S-02-2245. 31p. Dep. NTIS, PC A03/MF A01.

In Liquid Metal Fast Breeder Reactors (LMFBR) the fuel and blanket assemblies are subject to radial gradients in the rate of heat generations and have a wide range of flow conditions. An approximate method is presented for predicting temperature distributions in wire wrapped fuel assemblies based on a porous body model which was previously formulated by Khan. Numerical techniques were used for the solution of the equation set. However it was indicated that an analytical solution is possible for the case where the bundle is operating in forced convection only (negligible free convection). An analytical method is presented which, when combined with a very simple graphical construction, provides an engineering estimate of the temperature distribution in wire wrapped fuel rod assemblies.

26281 (COO—2245-40TR) **WARD blanket assembly pre-test predictions by SUPERENERGY.** Chiu, C.; Todreas, N.E. (Massachusetts Inst. of Tech., Cambridge (USA). Dept. of Nuclear Engineering). May 1977. Contract EY-76-S-02-2245. 67p. Dep. NTIS, PC A04/MF A01.

A heated LMFBR blanket assembly is under test at WARD to determine its thermal-hydraulic characteristics. Predictions of part of the WARD test results using the SUPERENERGY code with the aid of existing flow split and salt mixing data are presented. A significant part of this effort is the detailed consideration of the uncertainties introduced in temperature field predictions due to as-built bundle tolerances.

26282 (HEDL—6297) **US—UK technical exchange breeder reactor fuels: fuel pin chemistry.** Woodley, R.E. (Hanford Engineering Development Lab., Richland, Wash. (USA)). 14 Oct 1977. Contract EY-76-C-14-2170. vp. .

Included are thermochemical data for use in analysis of mixed-oxide fuel chemical behavior and data on in-core behavior of materials to control fuel-cladding chemical interaction. (DG)

26283 (ORNL/CSD/TM—35) **Calculation of the reactivity due to bubble collapse with the probability table method.** Hoffman, T.J.; Petrie, L.M. (Oak Ridge National Lab., Tenn. (USA)). Dec 1977. Contract W-7405-ENG-26. 29p. Dep. NTIS, PC A03/MF A01.

The probability table method, originally developed for unresolved resonance calculations, is adapted to the calculation of bubble worths in a reactor core. Unlike previous approaches to this problem, this method is applicable to a broad class of problems, avoids a high variance Monte Carlo calculation, and preseves the main features of a random bubble distribution. This approach is illustrated by the solution to several problems of varying degrees of complexity.

26284 (TID—28094) **SPTF Flow Loop 18 inch butterfly valve cavitation test report, SPTF-LPP.** Laird, R.A.; Bowers, W.M. (Liquid Metal Engineering Center, Canoga Park, Calif. (USA)). 29 Jun 1977. Contract EY-76-C-03-0700. 39p. .

Portions of document are illegible.

Cavitation testing of the HV-130 18 inch butterfly valve located in the Flow Loop at SPTF was conducted from March 22 to April 1, 1977. These tests were performed to determine cavitation characteristics as a function of valve position and upstream pressure in sodium at 600°F. Similar tests had been performed on the same valve using water as the flow medium. Three different test approaches for cavitation were used.

26285 (ANL-Trans—1121) **Device for thermal shielding of a reactor vessel.** Defauchy, J.; Malaval, C. Feb 1978. Translation of French Patent Application No. 74 37575. 16p. Dep. NTIS, PC A02/MF A01.

The invention deals with a device for thermal shielding of a reactor vessel. More specifically, this invention concerns a thermal shielding device for the vessel of an integrated liquid metal-cooled fast reactor in which the complete primary cooling circuit is located in the interior of the main tank.

26286 (ANL-Trans—1114) **Device for supporting the core of a fast neutron reactor.** Lleres, J.; Martin, J.P.; Perona, M.; Venot, R. Dec 1977. Translation of French Patent No. 7,336,035. 9p. Dep. NTIS, PC A02/MF A01.

The object of the invention is a supporting device for the core of a fast reactor cooled by a molten sodium circulation comprising a tank, a flooring mounted to this tank, a grid equipped with studs for the entry of the fuel elements, the grid which is supported by said flooring, a large number of tubes feeding the heat-transferring liquid sodium to the grid, characterized by the fact that said flooring consists of a rigid annular structure equipped with a plane annular bearing, that said grid includes a plane annular supporting bearing, seating of the grid on the flooring being assured by the support of said annular bearing of the grid on said annular supporting bearing of the flooring, and that the tubes opening into the grid to feed molten heat-transferring sodium are each connected to a structure connected to the flooring by means of an expansion bellows.

26287 (ANL-Trans—1113) **Installation for purifying the liquid metal used for cooling the core of a fast neutron reactor.** Abramson, R.; Delisle, J.P.; Elie, X. Dec 1977. Translation of French Patent No. 7,335,377. 12p. Dep. NTIS, PC A02/MF A01.

The invention deals with a purification installation for liquid metal and particularly sodium used to provide for cooling of the fuel assemblies of a fast-neutron reactor.

26288 (ANL-Trans—1112) **Turnstile device for fuel unloading of nuclear reactors.** Allain, A.; Mulot, P.; Filloleau, E. Dec 1977. Translation of French Patent No. 7,412,839. 13p. Dep. NTIS, PC A02/MF A01.

The invention deals with a turnstile transfer device for handling the fuel assemblies of a nuclear reactor, in particular of the fast neutron type cooled by circulating molten metal, generally sodium.

26289 (ANL-Trans—1111) **Process for the continuous control of the seal and strength of the containment of a reactor utilizing said process.** Cachera, P.C. Dec 1977. Translation of French Patent No. 7,332,374. 7p. Dep. NTIS, PC A02/MF A01.

The object of the invention is a process for the continuous monitoring of the seal and mechanical strength of the containment of a sodium-cooled fast reactor and the application of said process.

26290 Energy from nuclear reactors. Pt. 7. The gas breeder has some advantages: thorium as a fuel. Hospe, J. *VDI (Ver. Dtsch. Ing.) Nachr.;* **31**: No. 30, 12(Jul 1977). (In German).

HTR-type reactors are characterized by their high efficiency, rather low environmental pollution, and low uranium ore consumption. Further applications of economic interest are opened up by direct coupling with a gas turbine (single-cycle plant) and by the generation of nuclear process heat.

26291 Energy from nuclear reactors. Pt. 4. The fast breeder: better utilization of uranium. Hospe, J. *VDI (Ver. Dtsch. Ing.) Nachr.;* **31**: No. 27, 4(Jul 1977). (In German).

Fast breeders operate with fast neutrons. They are the only reactor type which produces by a breeding process more fission materials than it uses. On account of this property they are of great importance for long-term nuclear fuel supply.

26292 Advanced LMFBR fuels. Leary, J.; Kittle, H. (eds.). La Grange Park, IL; American Nuclear Society (1977). 705p. (CONF-771008—).

From International meeting on advanced LMFBR fuels; Tucson, AZ, USA (10 Oct 1977).

Separate abstracts are included for forty-two of the forty-six papers presented concerning the national advanced LMFBR fuels development program; irradiation testing experience for oxide fuels; recent developments in properties of advanced fuels; irradiation testing experience for carbide and nitride fuels; safety aspects of

advanced fuels; and irradiation performance analysis. Four papers have been previously included in the data base.

26293 US advanced LMFBR fuels development program. Simmons, J.M.; Leary, J.A.; Kittel, J.H.; Cox, C.M. pp 2-14 of Advanced LMFBR fuels. Leary, J.; Kittle, H. (eds.). La Grange Park, IL; American Nuclear Society (1977).

From International meeting on advanced LMFBR fuels; Tucson, AZ, USA (10 Oct 1977).

See CONF-771008—.

Following the oil crisis in 1974, a national Advanced LMFBR Fuels Development Program was initiated in the U. S. This program was developed on the basis of the experience obtained during the exploratory years. As a result, most aspects of advanced fuels development have been expanded in the U. S. in a unified national program. The experience obtained during the exploratory phase has been summarized previously. The purpose of this paper is to describe the new program and to summarize recent major findings.

26294 UK strategy and programmes for advanced LMFBR fuels. Bishop, J.F.W.; Chamberlain, A.; Gatley, J.A. pp 15-25 of Advanced LMFBR fuels. Leary, J.; Kittle, H. (eds.). La Grange Park, IL; American Nuclear Society (1977).

From International meeting on advanced LMFBR fuels; Tucson, AZ, USA (10 Oct 1977).

See CONF-771008—.

The first task for the UK is to develop a reliable plutonium oxide fuelled LMFBR with the associated plutonium storage, fabrication, transport, reprocessing and waste disposal parts of the complete fuel cycle in time for a substantial installation programme in AD 2000. This means a full scale demonstration in the first half of the 1990's. The second task is the establishment of this developed reactor system as part of the electricity generation network. For the purpose of this paper, two timescales can be delineated for objectives. The first is for oxide LMFBR systems. It is directed to a Demonstration Point of 1990 to 1995 and a continuing schedule leading to what we may call Fully Developed Oxide. The second is for other fuels and coolants where no dates have been fixed for Commercial Availability, but where these are definitely known to be later than the oxide timescale.

26295 SNR-carbide program: its position between present and future. Karsten, G. (Gesellschaft fuer Kernforschung, Karlsruhe, Ger.). pp 26-50 of Advanced LMFBR fuels. Leary, J.; Kittle, H. (eds.). La Grange Park, IL; American Nuclear Society (1977).

From International meeting on advanced LMFBR fuels; Tucson, AZ, USA (10 Oct 1977).

See CONF-771008—.

Information on the development of carbide-fueled LMFBR reactors is presented concerning ecological perspectives; the nuclear fuel cycle; fast reactor strategy; and program review and fuel pin concept.

26296 French advanced fuels development program. Pascard, R. (Centre d'Etudes Nucleaires de Fontenay-aux-Roses, France). pp 52-60 of Advanced LMFBR fuels. Leary, J.; Kittle, H. (eds.). La Grange Park, IL; American Nuclear Society (1977).

From International meeting on advanced LMFBR fuels; Tucson, AZ, USA (10 Oct 1977).

See CONF-771008—.

The aspects of the French carbide program are described. Since the beginning, it has experienced some inflexions but its main guide-lines are maintained. In particular, the Na-bonded fuel element is still the reference concept to be developed in priority. With maybe the exception of reprocessing, where obviously some effort is needed, the actual program, as it is shaped, should bring sufficient knowledge to make possible in a few years a full assessment of the future of carbide fuel in fast reactors.

26297 Japanese development program for advanced LMFBR fuels. Nomura, S. (Japan Atomic Energy Research Inst., Tokai); Shimokawa, J.; Uematsu, K.; Noro, K. pp 61-73 of Advanced LMFBR fuels. Leary, J.; Kittle, H. (eds.). La Grange Park, IL; American Nuclear Society (1977).

From International meeting on advanced LMFBR fuels; Tucson, AZ, USA (10 Oct 1977).

See CONF-771008—.

Information on the Japanese LMFBR fuels program is presented concerning the necessity and development program for advanced fuels; facility for mixed carbide, carbonitride, and nitride fuels; irradiation facilities in JOYO MK-2 core; and development program of advanced oxide fuels.

26298 Development of advanced fuels in Switzerland. Stratton, R.W. (Swiss Federal Inst. for Reactor Research, Wuerenlingen). pp 74-85 of Advanced LMFBR fuels. Leary, J.; Kittle, H. (eds.). La Grange Park, IL; American Nuclear Society (1977).

From International meeting on advanced LMFBR fuels; Tucson, AZ, USA (10 Oct 1977).

See CONF-771008—.

The development program for advanced carbide fuels for LMFBR reactors is described.

26299 CNEN program on advanced LMFBR fuels. Cecchi, P.; Covarelli, M.; Marucci, G.; Nobili, A. pp 86-93 of Advanced LMFBR fuels. Leary, J.; Kittle, H. (eds.). La Grange Park, IL; American Nuclear Society (1977).

From International meeting on advanced LMFBR fuels; Tucson, AZ, USA (10 Oct 1977).

See CONF-771008—.

CNEN activity on fast reactor fuels has been directed, in the past years, to the following purposes: study of basic phenomena affecting the in-pile behavior of fuel pins and feasibility studies of the vented-to-coolant fuel element and vibrocompacted fuel.

26300 UK irradiation experience relevant to advanced oxide fuel concepts for LMFBR's. Swanson, K.M.; Sloss, W.; Batey, W. pp 95-109 of Advanced LMFBR fuels. Leary, J.; Kittle, H. (eds.). La Grange Park, IL; American Nuclear Society (1977).

From International meeting on advanced LMFBR fuels; Tucson, AZ, USA (10 Oct 1977).

See CONF-771008—.

Most of the irradiation of oxide FR fuel in the UK has been in support of the driver charge fuel for PFR. Advanced oxide fuels mean fuels appreciably greater in linear rating and diameter than PFR driver charge fuels. The basic parameters of the two irradiated sub-assembly experiments to be described are given, along with those of the PFR driver charge for contrast. The irradiations were done in DFR, which completed its final run in March of this year, and the post irradiation examinations were done in the Dounreay cells.

26301 Experience and future plan of fast reactor oxide fuels irradiation in Japan. Uematsu, K. (Power Reactor and Nuclear Fuel Development Corp., Tokyo) Ishida, Y.; Komatsu, J. pp 110-121 of Advanced LMFBR fuels. Leary, J.; Kittle, H. (eds.). La Grange Park, IL; American Nuclear Society (1977).

From International meeting on advanced LMFBR fuels; Tucson, AZ, USA (10 Oct 1977).

See CONF-771008—.

The irradiation of mixed oxide fuels in Japan has been directed so far to the development of the JOYO MK-1 core fuels. This program has been successfully completed and proved the satisfactory behavior and stability of JOYO type fuels. Current irradiation program is mostly directed to MONJU type fuel pins and JOYO MK-II fuel pins. JOYO MK-II core will be used for the irradiation testing facility for advanced fuel and materials. Besides the steady-state irradiation experiments, non-steady-state irradiation experiments will be emphasized in the future. They are overpowered experiments, run to failure experiments, which are to define the performance limit, and load followed experiments. Defective fuel pin irradiation experiments are also programmed in the loop of JOYO MK-II core. Future program and some results obtained so far for fuel pins, subassembly, and cladding materials are described.

26302 Mechanical behavior of a fuel pin for fast reactors: effect of the fuel form and of the approach-to-power on the change of the fuel stack length under irradiation. Calza-Bini, A.; Caracchini, R.; Cosoli, G.; Filacchioni, G.; Lanchi, M.; Nobili, A.; Pesce, E.; Rocca, U.V.; Rotoloni, P.L. pp 122-135 of Advanced LMFBR fuels. Leary, J.; Kittle, H. (eds.). La Grange Park, IL; American Nuclear Society (1977).

From International meeting on advanced LMFBR fuels; Tucson, AZ, USA (10 Oct 1977).

See CONF-771008—.

Within the framework of an experimental programme, several fuel pins were irradiated. Measurements have been made on the change of the length of the fuel stack and of the cladding with power, temperature, and burnup. These experiments were done as an overall check of the pin behavior as well as to provide a key to interpret the contribution of the different phenomena to the observed changes. The present work consists of the analysis of the results obtained during three experiments in which the fuel was kept at a high heat rating. The behavior of solid and annular pellets has been compared; the effect of different approach-to-power rates has also been taken into account.

26303 US experience in irradiation testing of advanced oxide fuels. Cox, C.M. (Hanford Engineering Development Lab., Richland, WA); Hilbert, R.F.; Biancheria, A. pp 136-148 of Advanced LMFBR fuels. Leary, J.; Kittle, H. (eds.). La Grange Park, IL; American Nuclear Society (1977).

From International meeting on advanced LMFBR fuels; Tucson, AZ, USA (10 Oct 1977).

See CONF-771008—.

In June, 1977, 210 advanced oxide fuel elements had been irradiated or were under irradiation in EBR-II. By December, 1977, this total will be 294. Included are such design parameters as larger

pin diameters, smaller cladding thicknesses, and higher fuel smear densities than the reference FFTF fuel element design. Structural materials include 316 and D9 stainless steels, Inconel 706, and PE 16.

26304 Advanced mixed oxide fuel element for fast reactors. Delpeyroux, P.; Arnaud, G.; Ollier, H.; Mougniot, J. (CEA-CEN, Cadarache, France). pp 149-152 of Advanced LMFBR fuels. Leary, J.; Kittle, H. (eds.). La Grange Park, IL; American Nuclear Society (1977).

From International meeting on advanced LMFBR fuels; Tucson, AZ, USA (10 Oct 1977).

See CONF-771008—.

After definitive specification of the mixed oxide fuel element for Superphenix 1, two avenues were open in France for the development of the next generation of fuel element for this reactor type: a carbide fuel element which had been under lengthy investigation by C.E.A.; and an advanced mixed oxide fuel element adapted to the heterogeneous-core concept. The basic concept being pursued in the preliminary element project for Superphenix 2 is outlined here.

26305 Properties and irradiation behavior of advanced oxide particle fuel. Lahr, H.W.H. pp 153-164 of Advanced LMFBR fuels. Leary, J.; Kittle, H. (eds.). La Grange Park, IL; American Nuclear Society (1977).

From International meeting on advanced LMFBR fuels; Tucson, AZ, USA (10 Oct 1977).

See CONF-771008—.

Compared with the conventional pellet concept, fabrication of particle fuel has advantages in economy and in the reduction of the radiation burden to the personnel due to its capability of being automated. Moreover, the process is a very variable one; with minor modifications, oxides and carbides can be prepared for light water reactors, fast breeders and high-temperature reactors. Numerous irradiation tests did not yield disadvantages in the operating behavior, which are specifically attributable to this fuel variant. The tests described, which were, above all, intended to check the startup behavior of particle columns, prove that certain apprehensions concerning this fuel are unjustified for this phase of the operation.

26306 Mixed-nitride fuel performance in EBR-II. Bauer, A.A. (Battelle Columbus Labs., OH); Cybulskis, P.; Green, J.L. pp 299-312 of Advanced LMFBR fuels. Leary, J.; Kittle, H. (eds.). La Grange Park, IL; American Nuclear Society (1977).

From International meeting on advanced LMFBR fuels; Tucson, AZ, USA (10 Oct 1977).

See CONF-771008—.

Data have been obtained for a total of 42 fuel pins containing mixed-nitride fuel irradiated in EBR—II. Thirty-eight of the pins contained sodium-bonded fuel and four helium-bonded fuel. No failures occurred in the helium-bonded pins or in sodium-bonded pins in which the fuel was supported by internal shrouds. Fission-gas release data are presented along with observations concerning fuel and fuel-pin dimensional and structural changes and the influence of design and operating parameters on pin performance.

26307 UK irradiation experience relevant to advanced carbide fuel concepts for LMFBR's. Bagley, K.Q.; Batey, W.; Paris, R.; Sloss, W.M.; Snape, G.P. pp 313-325 of Advanced LMFBR fuels. Leary, J.; Kittle, H. (eds.). La Grange Park, IL; American Nuclear Society (1977).

From International meeting on advanced LMFBR fuels; Tucson, AZ, USA (10 Oct 1977).

See CONF-771008—.

Despite discouraging prognoses of fabrication and reprocessing problems, it is recognized that the quest for a carbide fuel pin design which fully exploits the favourable density and thermal conductivity of (U,Pu) monocarbide must be maintained. Studies in aid of carbide fuel development have, therefore, continued in the UK in parallel with those on oxide, albeit at a substantially lower level of effort, and a sufficient body of irradiation experience has been accumulated to allow discrimination of realistic fuel pin designs.

26308 German carbide irradiation test experience for fast reactors. Kummerer, K.R. (Kernforschungszentrum, Karlsruhe, Ger.). pp 326-342 of Advanced LMFBR fuels. Leary, J.; Kittle, H. (eds.). La Grange Park, IL; American Nuclear Society (1977).

From International meeting on advanced LMFBR fuels; Tucson, AZ, USA (10 Oct 1977).

See CONF-771008—.

Most of the open problems in carbide pin design and performance are of a very simple nature. As was the case with mixed oxide one or two decades ago, we must get experience in the parameter field of design and operation conditions. The main design parameters are carbide composition, density, internal geometry. The operation conditions in question are temperature and linear rod power and, of course, the achievable burnup. This field of experience should include steady-state as well as power-cycling and transient conditions. Finally the performance of representative carbide bundle structures are to be considered.

26309 French irradiation test experience for carbide fuels. Combette, P. (Centre d'Etudes Nucleaires de Fontenay-aux-Roses, France). pp 343-347 of Advanced LMFBR fuels. Leary, J.; Kittle, H. (eds.). La Grange Park, IL; American Nuclear Society (1977).

From International meeting on advanced LMFBR fuels; Tucson, AZ, USA (10 Oct 1977).

See CONF-771008—.

A research program has been performed at Commissariat a l'Energie Atomique to develop a carbide fuel element, for use in French breeder reactors. The major portion of the program is the evaluation of the performance of fuel elements irradiated in Osiris (thermal flux) or in Rapsodie (fast flux) reactors. The main parameters under investigation are the fuel pellet density (79 to 97 percent T.D., which corresponds to a smear density of 71 to 86 percent), the linear heat rating (70 to 140 kW/m), the burn up (up to 120,000 MWd/t) and the type of bond (He or Na). Up to now, a single grade of cladding material has been tested, solution annealed 316 stainless steel.

26310 Irradiation behavior of sphere-pac carbide fuel. Stratton, R.W.; Smith, L. (Swiss Federal Inst. for Reactor Research, Wuerenlingen). pp 348-360 of Advanced LMFBR fuels. Leary, J.; Kittle, H. (eds.). La Grange Park, IL; American Nuclear Society (1977).

From International meeting on advanced LMFBR fuels; Tucson, AZ, USA (10 Oct 1977).

See CONF-771008—.

A major part of the EIR programme developing (UPu)C sphere-pac fuel is the irradiation testing and subsequent post irradiation examination (P.I.E.) of vibro-filled fuel pins. Initial operating conditions were set to give maximum clad temperatures of approximately 650°C (sometimes exceeded) and peak linear ratings of 100 kW/m (often not attained). The FILOS series of irradiations in the EIR reactor SAPHIR have mean burn-up targets of 1 percent fima, most of the others in DIDO (UK), BR-2 (Belgium) and D.F.R. (Scotland) have reached mean values between 4 and 6.4 percent fima. All the tests reported have used fuel of two size fractions 600/800 μm and 40/60 μm. Smear density was in the range 76 to 77 percent theoretical. Plutonium content of the heavy metal is approximately 15 percent.

26311 Irradiation experiments of uranium carbide, carbonitride, and nitride fuels in JAERI. Watanabe, H.; Kurihara, M.; Shimokawa, J.; Ichikawa, M.; Uchida, M. (Japan Atomic Energy Research Inst., Tokai). pp 361-374 of Advanced LMFBR fuels. Leary, J.; Kittle, H. (eds.). La Grange Park, IL; American Nuclear Society (1977).

From International meeting on advanced LMFBR fuels; Tucson, AZ, USA (10 Oct 1977).

See CONF-771008—.

In JAERI, the irradiation test and analysis have been made to provide information on in-pile behavior of uranium carbide, carbonitride and nitride fuels as a preceeding stage examination for the mixed uranium-plutonium fuels. Five capsules containing UC, UC/sub x/N/sub 1-x/(x = 0.75, 0.5 and 0.25) and UN fuel pins were irradiated in JMTR (Japan Material Testing Reactor) to investigate their dimensional changes and swelling rates, and to examine the compatibility of the fuel pellets with the cladding materials under sodium or helium environment.

26312 U.S. advanced fuels safety program. Rose, D. (Argonne National Lab., IL); Opdenaker, A. pp 377-388 of Advanced LMFBR fuels. Leary, J.; Kittle, H. (eds.). La Grange Park, IL; American Nuclear Society (1977).

From International meeting on advanced LMFBR fuels; Tucson, AZ, USA (10 Oct 1977).

See CONF-771008—.

An advanced fuels safety program plan has been developed to provide a coordinated approach to resolving the safety issues arising from the use of the candidate advanced fuels (carbide/nitride) in LMFBRs. The advanced fuels safety program plan takes cognizance of the safety issues that have been identified for oxide-fueled LMFBRs, and of the safety technology required to resolve these issues. Specific additional technology needs are identified for advanced fuels. Thus, the program of work proposed builds on the similarities with work already in progress in the oxide program and focuses on the differences or issues unique to advanced fuels.

26313 Experimental study of advanced fuel-pin failure phenomena. Wrona, B.J.; Galvin, T.M. (Argonne National Lab., IL). pp 421-432 of Advanced LMFBR fuels. Leary, J.; Kittle, H. (eds.). La Grange Park, IL; American Nuclear Society (1977).

From International meeting on advanced LMFBR fuels; Tucson, AZ, USA (10 Oct 1977).

See CONF-771008—.

A direct-electrical-heating apparatus was used to perform fundamental fuel-motion experiments on unirradiated, clad and unclad UC pellets to investigate the response of the fuel to simulated

in-reactor transient heating rates and power levels. The results show that the response of UC to applied power transients is significantly different than UO_2 behavior in similar situations. Because of the large temperature interval between the boiling and melting points of UC and the high thermal conductivity of UC that results in relatively flat radial temperature gradients, two regimes of gross fuel motion can occur, depending upon the fuel centerline temperature.

26314 GFEK experimental approach to carbide fuel element licensing. Plitz, H. (Gesellschaft fuer Kernforschung, Karlsruhe, Ger.). pp 433-454 of Advanced LMFBR fuels. Leary, J.; Kittle, H. (eds.). La Grange Park, IL; American Nuclear Society (1977).

From International meeting on advanced LMFBR fuels; Tucson, AZ, USA (10 Oct 1977).

See CONF-771008—.

Information is presented concerning the general approach to licensing the reference carbide fuel elements; design basis of the reference carbide fuel element concept; theoretical and feasible pin design aspects; irradiation statistics, experimental failure limits; incidental behavior and safety aspects; and experimental approach to licensing the reference carbide fuel element.

26315 Case for fuel redesign after in pile safety experiments: the "COMMANDO" tests. Chagrot, M. pp 455-467 of Advanced LMFBR fuels. Leary, J.; Kittle, H. (eds.). La Grange Park, IL; American Nuclear Society (1977).

From International meeting on advanced LMFBR fuels; Tucson, AZ, USA (10 Oct 1977).

See CONF-771008—.

The CEA reference design for LMFBR advanced fuel elements consisted of mixed carbide sintered pellets stacked in vented, stainless steel clad pins with a large liquid sodium bonded gap. For clearing up the uncertainties of pin behavior, in the case of bond blow-out, two tests were performed in the SCARABEE loop. This experimental program, named COMMANDO, although limited, yielded satisfactory results. The tests showed that no damageable cladding melting occurred and that a new workable steady-state was almost immediately recovered. From these findings and, although other concepts are now considered as well, a safer pin design was devised.

26316 Correlation between properties and irradiation behavior for carbide, carbonitride and nitride fuels. Blank, H. (Joint Research Centre, Karlsruhe, Ger.). pp 482-501 of Advanced LMFBR fuels. Leary, J.; Kittle, H. (eds.). La Grange Park, IL; American Nuclear Society (1977).

From International meeting on advanced LMFBR fuels; Tucson, AZ, USA (10 Oct 1977).

See CONF-771008—.

A description is presented of the general fuel and pin behaviour on the basis of the presently available information of the project and is organized in the following way: the results of an analysis of the complex system reactor-cladding-fuel in order to fix the parameters and their range of values in the problem of swelling; a description of the general pin behaviour follows as obtained from intermediate and final measurements of the permanent diameter increases ($\Delta D/D$) of the fuel pins; a detailed description of fuel restructuring and its correlation with the basic fuel properties; and the results are summarized and conclusions drawn about the potential of the various types of fuels and pins with regard to fuel composition.

26317 Irradiation performance analysis of UK fast reactor fuel. Bellamy, R.G.; Hayns, M.R.; Matthews, J.R.; Wilmore, D. pp 502-515 of Advanced LMFBR fuels. Leary, J.; Kittle, H. (eds.). La Grange Park, IL; American Nuclear Society (1977).

From International meeting on advanced LMFBR fuels; Tucson, AZ, USA (10 Oct 1977).

See CONF-771008—.

Two theoretical fuel element models are used in the UK fast reactor fuel program. SLEUTH was originally developed to study gas cooled thermal reactor problems, while FRUMP was specifically developed for operational and safety studies of fast reactor fuel element behaviour.

26318 Progress in modeling carbide and nitride fuel performance in advanced LMFBRs. Billone, M.C.; Jankus, V.Z.; Kramer, J.M.; Yang, C.I. (Argonne National Lab., IL). pp 516-536 of Advanced LMFBR fuels. Leary, J.; Kittle, H. (eds.). La Grange Park, IL; American Nuclear Society (1977).

From International meeting on advanced LMFBR fuels; Tucson, AZ, USA (10 Oct 1977).

See CONF-771008—.

The UNCLE-S and UNCLE-T codes have been developed to predict the steady-state and transient performance of (U,Pu)C and (U,Pu)N fuels in advanced LMFBRs. The fuel models and properties that have been incorporated into those codes and the comparison between code predictions and postirradiation data are reviewed. The need for further model development in the areas of fuel cracking and healing, fuel melting, fission-gas release and swelling, and high strain-rate fuel deformation are established. An improved model for fuel cracking is proposed.

26319 Analytical comparison of the irradiation behavior of fast reactor carbide and oxide fuel pins. Nayak, U.P.; Boltax, A.; Skalka, R.J.; Biancheria, A. (Westinghouse Electric Corp., Pittsburgh). pp 537-561 of Advanced LMFBR fuels. Leary, J.; Kittle, H. (eds.). La Grange Park, IL; American Nuclear Society (1977).

From International meeting on advanced LMFBR fuels; Tucson, AZ, USA (10 Oct 1977).

See CONF-771008—.

Advanced breeder reactor system design studies indicate that mixed U,Pu carbide fuel provides potential advantages over mixed U,Pu oxide fuel related to nuclear, fuel cycle, and safety considerations. However, the state-of-the-art technology on carbide fuel lags the large world-wide effort on oxide fuel. An analytical comparison of the two fuel types under steady-state and transient conditions using the current versions of the LIFE fuel performance codes is presented.

26320 LIFE code system for analysis of oxide fuel pin thermal/structural behavior. Stephen, J.D.; Biancheria, A.; Billone, M.C. pp 562-581 of Advanced LMFBR fuels. Leary, J.; Kittle, H. (eds.). La Grange Park, IL; American Nuclear Society (1977).

From International meeting on advanced LMFBR fuels; Tucson, AZ, USA (10 Oct 1977).

See CONF-771008—.

The LIFE development program is providing national methods for thermal and mechanical analysis and design of FBR fuel pins. The program has produced the LIFE3 code and is developing LIFE4 and LIFE4-transient for $(U,Pu)O_2$, has encouraged the spin-off development of the UNCLE code for (U,Pu) Carbide and Nitride, and is in the early stages of development of codes for UO_2 $(Th,U)O_2$, ThO_2 and other blanket and alternate fuel concepts.

26321 Development of LMFBR core designs using reference and advanced oxide fuel. Chandler, J.C.; Marr, D.R.; McCurry, D.C.; Cantley, D.A.; Omberg, R.P. (Hanford Engineering Development Lab., Richland, WA). pp 583-593 of Advanced LMFBR fuels. Leary, J.; Kittle, H. (eds.). La Grange Park, IL; American Nuclear Society (1977).

From International meeting on advanced LMFBR fuels; Tucson, AZ, USA (10 Oct 1977).

See CONF-771008—.

The design of an LMFBR core is a complex process which is strongly dependent upon design philosophy, design criteria, selection of material properties, and the calculational procedure involved. The development of a core design with optimum characteristics, whether it be doubling time, power costs, or safety characteristics, requires a close coupling of the disciplines of reactor physics, thermohydraulics, mechanical design, and fuel pin performance. This, by necessity, forces the development of a closely-coupled multidiscipline approach. This is true regardless of whether the fuel is oxide, carbide, nitride, or metal, and regardless of whether the fuel cycle is Pu/U or U-233/Th.

26322 Assumptions, constraints and methodology of ANL advanced fuels system studies. Barthold, W.P.; Lam, S.K.; Orechwa, Y. (Argonne National Lab., IL). pp 594-613 of Advanced LMFBR fuels. Leary, J.; Kittle, H. (eds.). La Grange Park, IL; American Nuclear Society (1977).

From International meeting on advanced LMFBR fuels; Tucson, AZ, USA (10 Oct 1977).

See CONF-771008—.

A preliminary assessment has been made at ANL of the breeding performance of carbide and nitride fuels in 2000 MWe LMFBRs, and its sensitivity to changes in design and performance parameters. In addition, various design trade-off studies, as well as special problems connected with the design of large LMFBRs, were investigated. The preliminary nature of this assessment is a reflection of the lack of data related to the irradiation behavior of these fuels. Both types of fuel were either sodium- or helium-bonded to the cladding. The assumptions and constraints used throughout the study and the methodology employed for the performance and design analysis are summarized. Typical results are given as examples.

26323 Optimization system design studies of advanced carbide fuel. Caspersson, S.A.; Noyes, R.C.; Kulwich, M.R.; diLauro, G.F.; Klinetob, R.H. (Combustion Engineering, Inc., Windsor, CT). pp 614-633 of Advanced LMFBR fuels. Leary, J.; Kittle, H. (eds.). La Grange Park, IL; American Nuclear Society (1977).

From International meeting on advanced LMFBR fuels; Tucson, AZ, USA (10 Oct 1977).

See CONF-771008—.

System design studies of advanced helium and sodium-bonded uranium-plutonium carbide fuel in commercial LMFBR's have been completed to develop recommendations for optimum values of advanced fuel pin design parameters. Fuel cycle costs, doubling times,

and uranium ore requirements were applied as principal optimization criteria. When fuel pin diameter is allowed to vary, higher linear powers result in lower achievable fuel cycle costs and give low doubling times and low uranium ore requirements.

26324 Investigation of sodium-bonded carbide fuel assembly design. Madell, J.T.; de Paz, J.F.; Yang, C.I. (Argonne National Lab., IL). pp 634-647 of Advanced LMFBR fuels. Leary, J.; Kittle, H. (eds.). La Grange Park, IL; American Nuclear Society (1977).

From International meeting on advanced LMFBR fuels; Tucson, AZ, USA (10 Oct 1977).

See CONF-771008—.

The engineering studies consisted of steady-state thermal-hydraulic analysis of the fuel assembly, transient thermal analysis of advanced fuel cores, performance studies of pin spacer types, structural analysis of the duct, flow induced vibration analysis, core resistant analysis and cladding structural lifetime calculations. The results of this study will be incorporated into a new assembly design.

26325 Design and performance of shroud tubes. Kerrisk, J.F.; Barner, J.O.; Petty, R.L. (Los Alamos Scientific Lab., NM). pp 648-659 of Advanced LMFBR fuels. Leary, J.; Kittle, H. (eds.). La Grange Park, IL; American Nuclear Society (1977).

From International meeting on advanced LMFBR fuels; Tucson, AZ, USA (10 Oct 1977).

See CONF-771008—.

Shroud tubes were conceived as a means of preventing the rearrangement and wedging of broken fuel pieces in sodium-bonded advanced-fuel elements. The specific design of a thin-walled tube with slots that fits closely around the fuel was arrived at by consideration of a number of competing mechanical and heat-transfer requirements. Postirradiation examination results obtained to date indicate that shroud tubes are meeting the design requirement of retaining fuel fragments. No cladding failures have been observed in any sodium-bonded element using a shroud tube. The excellent irradiation performance of sodium-bonded elements with shroud tubes as compared to similar elements without shroud tubes demonstrates the utility of the shroud-tube concept.

26326 Status of international fuel cladding development. Laidler, J.J. (Hanford Engineering Development Lab., Richland, WA). pp 681-694 of Advanced LMFBR fuels. Leary, J.; Kittle, H. (eds.). La Grange Park, IL; American Nuclear Society (1977).

From International meeting on advanced LMFBR fuels; Tucson, AZ, USA (10 Oct 1977).

See CONF-771008—.

Several substantial national and international programs on cladding and duct materials development are currently in progress, and great strides are being made in characterizing the behavior of current reference materials and in developing materials with improved performance capabilities. A brief overview of these programs, the state of materials development, and the nature of some current important issues pertaining to materials behavior in the reactor environment are presented.

26327 Safety device in a nuclear reactor fuel rod with a closed fission gas plenum. Gast, K. (to Gesellschaft fuer Kernforschung m.b.H., Karlsruhe (Germany, F.R.)). German(FRG) Patent 2,023,250/C/. 23 Dec 1976. 2p. (In German).

The invention deals with the design of the fission gas plenum of fuel rods for nuclear reactors cooled with liquid metal. The fission gas plenum is subdivided by honeycombed partition walls - preferably of dry powdered metal - being fully permeable for fission gases. In this way a slow, uniform pressure build-up is guaranteed. If the can of the fuel rod fails in this area, the stored amount of fission gas is released only delayed. The invention increases the safety of the fuel elements equipped with the device.

26328 Fuel element for fast nuclear reactors. Swanson, K.M. (to UKAEA London Office). German(FRG) Patent 1,614,932/B/. 16 Dec 1976. 4p. (In German).

Fuel elements for fast nuclear reactors containing ceramic fuel tend to rupture of the fuel can, the fuel beginning to swell under the influence of radiation. For a remedy, it is proposed to choose the composition so that the density of the fuel filled in remains below 85% of the maximum possible density, thus cavities distributed over the fuel string are being included. This may be achieved, e.g., by recesses in the individual fuel particles. According to the invention, in addition to the fuel, also reflecting material (e.g. in the form of corrugated foil from a hardly fusible metal) may be placed in the gap between the inner and the outer tube of the fuel rod, thus increasing the heat insulation of the gap.

26329 Fuel rod for liquid metal-cooled nuclear reactors. Vinz, P. (to Messerschmitt-Boelkow-Blohm G.m.b.H., Muenchen (Germany, F.R.)). German(FRG) Patent 2,449,597/B/. 16 Dec 1976. 5p. (In German).

In fuel rods for nuclear reactors with liquid-metal cooling (sodium), with stainless steel tubes with a nitrated surface as canning, superheating or boiling delay should be avoided. The inner wall of the can is provided along its total length with a helical fin of stainless steel wire (diameter 0.05 to 0.5 mm) to be wetted by hot sodium. This fin is mounted under prestressing and has a distance in winding of 1/10 of the wire diameter.

26330 Fuel assembly for a nuclear reactor. Cross, A.; Lunt, A.R.; Doherty, J.B. (to UKAEA London Office). German(FRG) Patent 2,620,343/A/. 18 Nov 1976. 15p. (In German).

An improvement is proposed for the arrangement of the fuel rods for a liquid metal-cooled reactor. The sleeve enclosing a fuel rod cluster has a throttling device permitting the coolant to take one of several axial flow paths, an isolating valve opening one flow path or the other. The sleeve is inserted into the grate by means of a guide pin, the throttling device consists of inner and outer tube elements, twistable with respect to each other, as well as a number of discs, arranged crosswise within the inner tube, whose geometric shape and design is described.

POWER REACTORS, AUXILIARY, MOBILE, PACKAGE, AND TRANSPORTABLE

REFER ALSO TO CITATION(S) 26705

REGULATION AND LICENSING

REFER ALSO TO CITATION(S) 26243

26331 (RDT-INDEX—(1-78)) **RDT Standards index.** (Department of Energy, Washington, D.C. (USA). Div. of Nuclear Power Development). Jan 1978. Contract W-7405-ENG-26. 34p. .

A list of RDT Standards is presented for the period of October through December 1977.

26332 (TID—28078) **Viewpoints on key issues and evaluation criteria for assessing the potential of alternative nuclear energy systems for improving proliferation resistance.** (Booz, Allen and Hamilton, Inc., Bethesda, Md. (USA)). 15 Dec 1977. Contract EN-77-C-01-2644. vp. Dep. NTIS, PC A05/MF A01.

The report presents a compilation and analysis of the viewpoints offered by over 50 individuals representative of the spectrum of groups interested in the proliferation problem. These individuals were selected from utilities, the nuclear industry, the Federal Government, state government staff, Congressional staff, environmental organizations, universities, an energy analysis organization, national energy laboratories, and a public policy analysis organization. The major issues, concerns, and implications identified in the course of this effort are discussed. This analysis of viewpoints is intended to assist DOE in the planning and conduct of a Nonproliferation Alternative System Assessment Program (NASAP). Information is presented in the following formats: framework for analysis; alternative systems assessment criteria; integrated evaluation methodology; and public interaction.

26333 Sunningdale seminar on nuclear policy: a summary of the discussions. Benn, A.W. (Department of Energy, London (UK)). *Atom (London);* No. 251, 199-206,226(Sep 1977).

From Seminar on nuclear energy policy; Sunningdale, UK (13 - 14 May 1977).

This is a summary of discussions at the seminar published by the UK Secretary of State for Energy under the following headings: First session - the long-term role of nuclear power; Second session - thermal and fast reactor policy; Third session - the nuclear fuel cycle.

26334 Publication of safety criteria for nuclear power plants, dated 21st October 1977. *Gut;* No. 39, 1-7(1977). (In German).

The full text of the criteria is published once more. It also contains criterion 1.1. - principles of safety provision - not included in the first publication (BAZ No. 106, 8th June 1977), and amended definitions of the terms discharge and release of radioactive substances.

ECONOMICS

26335 Swedish nuclear power industry. A survey. *Arch. Energiewirtsch.;* **31**: No. 6, 475-484(Jun 1977). (In German).

This is a survey of the electric power supply situation in Sweden. For the future, politicians intend to rely less strongly on oil and to reduce the growth of energy consumption. Nuclear power is utilized mainly in LWR reactors, 5 of which are in operation at present. Due to its extensive domestic uranium reserves and advanced mechanical engineering, Sweden has good chances to realize

a nuclear power programme which is in accordance with its envisaged energy policy.

26336 How Germany came to have nuclear energy: a stop halfway. Martin-Edingshaus, L. *Bild Wiss.;* **14**: No. 5, 92-104(May 1977). (In German).

A description of the FRG's nuclear energy development during the last decade is presented. The policies on nuclear energy of the Federal government are reflected above all in the development of the two promising reactor type lines HTR and FB. This development was also very much determined by the behaviour of industry, as the consequences they drew were of a commercial kind which led to a concentration without development being stimulated. Other constraining facts and a public which has become more critical have gained a lot of influence, the effects of which are not known yet.

26337 Nuclear power. Analyses and prognoses. *Analusis;* **9**: No. 1, 6(Jan 1977). (In German).

Sites of existing and planned nuclear power plants in the Federal Republic are reviewed along with. Dates of start-up, data on power and type of the power plants. Installed power of nuclear power plants in Europe, Asia, North and South America, as per November 1976 are listed.

CONSTRUCTION AND OPERATION

26338 (AD-A—043701) **Analysis of nuclear and coal fueled total energy system options for Fort Knox, Kentucky. Final technical report, June 1976—June 1977.** Best, F.R.; Goldman, S.B.; Golay, M.W. (Massachusetts Inst. of Tech., Cambridge (USA). Dept. of Nuclear Engineering). 30 Jun 1977. Contract DAAK02-74-C-0308. 317p. Microfiche copies only.

A Total Energy System is designed to supply the thermal and electrical energy requirements of Fort Knox for 30 years, with startup scheduled for early 1985. Considered for use as the central station power plant for this system are a combined coal gasification, fossil-fired gas turbine (CGGT) power plant and a direct Brayton cycle high-temperature gas-cooled reactor, helium gas turbine (HTGR/GT) power plant. Several utility system configurations affording different thermal/electrical energy demand ratios are studied for each supply option. It is found that the optimal thermal/electrical load split for each supply option occurs at approximately 80% of the base's total energy demands supplied thermally. Within the limits of the unit-cost assumptions made and for the range of cases studied, it is found that the present-worth total cost of the optimized HTGR/GT system (in 1985 dollars) is $234.5 million and the corresponding optimal system cost for the fossil CGGT alternative is $182.2 million.

FUEL CYCLE

REFER ALSO TO CITATION(S) 26295

PROCESS HEAT REACTORS

REFER ALSO TO CITATION(S) 25894, 26544, 26705

26339 Steam only from small reactor looks more attractive than coal. Smith, D. *Nucl. Eng. Int.;* **22**: No. 262, 75-77(Sep 1977).

The potential application of the BandW Consolidated Nuclear Steam Generator for production of process steam only, is examined. Brief details of the 365 MWt packaged PWR reactor are reviewed. Capital and operating cost estimates, and also steam costs, are compared with those for two hypothetical coal burning plants. Production costs are also compared with the cost of steam generated from oil, showing the effect of the fixed charge rate on the nuclear plant economy.

26340 Energy from nuclear reactors. Pt. 6. The gas-cooled HTR: reactivation of coal. Hospe, J. *VDI (Ver. Dtsch. Ing.) Nachr.;* **31**: No. 29, 2(Jul 1977). (In German).

The author emphasizes the significance of gas-cooled HTRs for the generation of process heat, in particular for coal gasification, deals with the problems which arose when looking for a suitable coolant and fuel element, and describes the refuelling principle in the case of spherical fuel elements being used. Safety problems are discussed briefly.

NUCLEAR REACTOR TECHNOLOGY

26341 Energy research program of the Federal Republic of Germany. Popp, M. (Bundesministerium fuer Forschung und Technologie, Bonn (Germany, F.R.)). *Atomwirtsch., Atomtech.;* **22**: No. 10, 526-534(Oct 1977). (In German).

From Reactor congress 1977; Mannheim, Germany, F.R. (29 Mar - 1 Apr 1977).

The new Energy Research Program, which for the first time will represent a complete picture of both nuclear and non-nuclear energy research, will conclude the era of the Atomic Power Programs. A total of DM 6.532 billion has been earmarked for the new Energy Research Program, of which DM 490 million will go into the development of rational uses of energy in the application and secondary sectors, DM 940 million into coal processing and other fossil sources of primary energy, DM 570 million into new energy sources, and DM 4.532 billion into nuclear power. In the nuclear power sector light water reactors will no longer be funded. However, for this sector financing of research and development of uranium enrichment and reprocessing and ultimate storage of radioactive waste will be continued. Most of the grants will go into the completion of current major projects, i.e., THTR-300 for the high temperature reactor line and SNR-300 for the LMFBR line, and into the R+D program on the development of a large uranium enrichment plant based on the gas centrifuge process. Additional funds will be spent on work improving the reactor safety of LWR plants.

26342 Standardization in nuclear engineering. Reihlen, H. (DIN Deutsches Inst. fuer Normung e.V., Berlin (Germany, F.R.)); Schwarzer, W. (Kerntechnischer Ausschuss (KTA), Koeln (Germany, F.R.)). *Infrared Phys.;* No. 3, 1-3(Jul 1977). (In German).

DIN and KTA have come to an agreement, the aim of which is to create a uniform and consistent book of rules in nuclear engineering for the FRG. A considerable proportion of subsequent standardization work in nuclear engineering by DIN will then continue to be carried out in agreement with the KTA, as is the case now. DIN with its 'Normenausschuss Kerntechnik' (NKe) has in addition tasks to fulfill, i.e. standardization on other relevant sectors, which exceed the KTA field of work. Representing German interest at the International Standardization Organization (ISO) remains also another one of DIN's tasks. In order to avoid unnecessary divergences, the KTA commits itself to adapt its rules of procedure to those of DIN as far as this is possible.

26343 Kerntechnik. (Nuclear engineering). Roehrdanz, K. Wuerzburg, Germany, F.R.; Vogel Verl. (1977). 120p. (In German).

This pocket edition deals in eleven brief chapters with the principles of nuclear physics, nuclear physics measurements, particle accelerators, and the theory of nuclear reactors and fusion reactors.

26344 Current papers in nuclear energy. *Ann. Nucl. Energy;* **4**: No. 9, 476-480(1977).

Over 100 references are listed to current journal literature covering various aspects of nuclear reactors including reactor physics, safety, fuels and other materials, heat transfer etc.

THEORY AND CALCULATION

26345 (LA—6807-PR, pp 72-79) **Fission reactor critical experiments and analysis.** May 1977.

In Energy technology. Progress report, January—March 1977.

Work accomplished in support of nonweapons programs by LASL Group Q-14 is described. Included are efforts in basic critical measurements, nuclear criticality safety, a plasma core critical assembly, and reactivity coefficient measurements.

26346 FLEX: a code for calculating neutron flux microdistributions in lattices consisting of hexagonal fuel assemblies. Agthe, G.; Mai, W.; Moeller, W.; Mueller, A. (VEB Kombinat Kraftwerksanlagenbau, Berlin (German Democratic Republic)). *Kernenergie;* **21**: No. 1, 18-22(Jan 1978). (In German).

Physical and mathematical fundamentals as well as the coarse structure of the FLEX code are reviewed. In a flexible manner this programme allows one to calculate two-dimensional neutron flux and power density microdistributions in hexagonal geometry for both regular lattices of fuel elements as they exist in zero power reactors and lattices consisting of hexagonal fuel assemblies of WWER type or FBR type reactors. The gaps between fuel rod bundles provided for reasons of design (assembly cans, coolant) can be taken into account in detail. Some results of recalculating test set-up experiments are given.

26347 Integral representation of the GREEN function for time-dependent processes in one-group diffusion approximation. Meyer, K. (Ingenieurhochschule Zittau (German Democratic Republic). Sektion Kraftwerksanlagenbau und Energieumwandlung). *Kernenergie;* **21**: No. 1, 13-15(Jan 1978). (In German).

A representation of the Green function by an integral in the complex plane is given for calculating time-dependent processes in a nuclear reactor, which are caused by external sources. The proper-

ties of the integrand are discussed. Possibilities of further applications of the statement are shown.

26348 Dynamics of nucleate region flow boiling. Peterson, W.C. (North Carolina State Univ., Raleigh (USA)); Zaalouk, M.G. (Carolina Power and Light Co., Raleigh, N.C. (USA)). *Nucl. Eng. Des.;* **44**: No. 2, 163-170(Nov 1977).

A transfer function to describe boiling dynamics has been developed analytically. Dynamic measurements were performed for pool boiling and experimental functions were developed. Flow boiling dynamics were then investigated. Results obtained for negative h region flow boiling dynamics have been presented. The present study concerns nucleate region flow boiling dynamics.

26349 Finite element nonlinear heat transfer analysis using a stable explicit method. Trujillo, D.M. (Holmes and Narver, Inc., Anaheim, Calif. (USA)); Busby, H.R. (California State Univ., Fullerton (USA)). *Nucl. Eng. Des.;* **44**: No. 2, 227-233(Nov 1977).

The explicit stable method of Saulev is applied to nonlinear finite element heat conduction. Several nonlinear example problems are considered which include temperature-varying material properties and radiation boundary conditions.

26350 Analysis of possibility of reactors occurring in nature. Kuroda, P.K. (Arkansas Univ., Fayetteville (USA). Dept. of Chemistry). *Nippon Genshiryoku Gakkaishi;* **19**: No. 4, 225-232(Apr 1977). (In Japanese).

A historical account is presented of the sequence of events which led to the 1956 prediction by the author that nuclear reactors should have existed in nature approximately 2 billion years ago. Following a brief review of the natural reactor theory, some of the results from recent studies of the Oklo Phenomenon are discussed. The report consists of the following chapters: I. Introduction, II. Natural Reactor Theory, III. The Oklo Phenomenon-Models of Natural Reactors, IV. Possibility of the Graphite-type Natural Reactor, V. The Sudbury Phenomenon, and VI. Conclusion. The Chap. IV deals with the studies on the occurrence of fissiogenic xenon isotopes in the carbon-rich mineral thucholite from the Besner Mine, Parry Sound, Ontario, Canada. The thucholite contained fissiogenic xenon isotopes from ^{238}U spontaneous fission, but not from ^{235}U neutron-induced fission. The Chap. V deals with the studies of the abundance pattern of Ne, Ar, Kr and Xe in several granite samples, including the Red Rock granite from the Sudbury structure, Ontario, Canada, which, according to Dietz (1964), was formed by the impact of an asteroid about 1.7 billion years ago. No unusual concentration of fissiogenic xenon isotopes was detected in the Red Rock granite, but the observed rare gas abundance pattern resembled that in meteorites, rather than the terrestrial rare gas abundances.

26351 Identification of a nuclear reactor system by means of gradient methods. Kuroda, Y.; Mori, Y. (Tokai Univ., Tokyo (Japan). Faculty of Engineering). *Tokai Daigaku Kiyo Kogakubu;* **1976**: No. 2, 89-97(Mar 1977). (In Japanese).

This paper describes a simulation study on the parameter estimation of a Nuclear reactor system. The model used is a coupled lumped parameter system which represents a reactor dynamics with temperature feedback. The problem is to estimate a parameter, i.e., coolant velocity from observation data, i.e., reactor power, fuel and coolant temperature, which are obtained in advance by applying disturbances to the model. Estimation procedure is based on the gradient and conjugate gradient method, using a quadratic cost function. Emphasis is placed on the examination of the way of convergence about the both methods under noisy environment. To do this, use is made of two kinds of inputs, i.e., pulse wave and Gaussian noise, on which the goodness of estimation is discussed numerically.

26352 Two-group diffusion calculation through pseudo-continuous synthesis. Watson, F.V. (Rio de Janeiro Univ. (Brazil). Coordenacao dos Programmas de Pos-Graduacao de Engenharia); Fill, H.D.O.A. (Companhia Paranaense de Electricidade, Curitaba (Brazil)). *Atomkernenergie;* **30**: No. 3, 216-218(1977).

A spatial synthesis algorithm which combines the advantages of the continuous and the discontinuous synthesis is presented. The method is designed for the solution of the static three-dimensional two-group eigenvalue diffusion equations associated to thermal reactors and displays the following features: (a) standard multigroup codes can be used to compute one- and two-dimensional solutions, (b) strong discontinuities of material parameters along the one-dimensional direction are allowed, and (c) any possible ill-conditioning of the synthesis equations is eliminated. A computer code designed for routine two-group calculations of PWR reactors with partially inserted control rods has been developed.

26353 Solution of the time-dependent multi-group neutron transport equation using spherical harmonics. Fletcher, J.K. (UKAEA Reactor Group, Risley). *Ann. Nucl. Energy;* **4**: No. 9, 401-405(1977).

The time-independent multi-group neutron transport equation is solved by expressing the neutron flux for each energy group in the form PHI(r,Ω) = the sum of l = 0 to N the sum of m = 0 to l (2l + 1)Psub(l)sup(m)(cos theta)(PSIsub(lm)r)cos(mphi) + γsub(lm)(r sin(mtheta)) where PHI(r,Ω) is the flux at r in direction Ω. The moments PSIsub(lm)(r) and γsub(lm)(r) are functions of the position r and Psub(l)sup(m)(cos theta) is the associated Legendre polynomial of order lm. Theta and phi are the spherical co-ordinates of Ω i.e. theta is the angle to the z-axis and phi the angle the projection of Ω on to the x-y plane makes with the x-axis. N is the order of the approximation. The resulting moment equations obtained after equating coefficients of Psub(l)sup(m)(cos theta) cos(mphi) and Psub(l)sup(m)(cos theta) sin(mphi) are transformed, by eliminating PSIsub(lm)(r) and γsub(lm)(r) with odd l, to linked second order differential equations for those with even l. These are solved by the familiar algorithms of diffusion theory.

26354 Determination of the 'transit' time between two cores by a noise analysis method. Genoud, J.P. (Ecole Polytechnique, Lausanne (Switzerland). Lab. de Genie Atomique). *Ann. Nucl. Energy;* **4**: No. 9, 435-442(1977).

A model for a two loosely coupled cores reactor, whose neutronic behaviour is investigated on the basis of a stochastic formulation, is developed. This study aims at describing a process with delay time by a Markov process. The influence of the neutron 'transit' time from one core to the other on the cross-power spectral density of the neutronic noise, is analysed, and the properties of the coherence functions are described. To test the validity of the model, noise experiments have been performed in the coupled cores reactor of the Physikalisch-Technische Bundesanstalt (PTB) in Braunschweig and the results are presented.

26355 Neutron transit time measurements on a two-different-core system. Tai, A.S.; Schneeberger, J.P. (Ecole Polytechnique Federale, Lausanne (Switzerland)). *Ann. Nucl. Energy;* **4**: No. 9, 443-448(1977).

A very simple method is proposed for determining experimentally the mean neutron transit time between the two zones of a multiplying system. The method is based on the well known pulses neutron technique. The measurements are carried out on a system of two different zones separated by a more or less absorbing medium. The results obtained show that this transit time varies in the same way as the neutron lifetime in the intermediate medium and depends on the direction of the neutron propagation from one zone to the other.

COMPONENTS AND ACCESSORIES

REFER ALSO TO CITATION(S) 25932

26356 (EPRI-NP—534) Long term performance of charcoal absorbers removing radioiodine in ventilation exhaust air. Final report. Pelletier, C.A.; Barefoot, E.D.; Hemphill, R.N.; Frederickson, J.P. (Science Applications, Inc., Rockville, Md. (USA)). May 1977. 50p. Dep. NTIS, PC A03/MF A01.

Continuous measurements of the efficiency of two charcoal filters for absorbing iodine-131 in ventilation exhaust air were made at the Ginna nuclear power plant. Measurements were made for 416 days beginning on 5/28/75 and ending on 7/8/76. During the last 280 days, efficiencies for four chemical forms of iodine-131 were measured. The four chemical forms were elemental, hypoiodus acid, organic and iodine-131 on particulate matter. Measurements for one charcoal installation were started at the time new charcoal had been installed. The other filter contained charcoal which had been exposed for two years prior to the initiation of the measurements. In the case of the installation with new charcoal, decontamination factors (DF) for all forms of iodine-131 except that on particulate matter were from 50 to 100 and showed little tendency to decrease over the first 400 days. The DF for iodine-131 on particulate matter was 2.9. This low DF is attributed to the fact that the installation contained no High Efficiency Particulate Air (HEPA) prefilters. In the case of the other charcoal installation (which did contain HEPA filters) the DF for organic iodine after two year's exposure was 3.5. At three years exposure the DF for organic iodine had decreased to 2. The DF for the non-organic forms was higher. Measurement sensitivities coupled with low input concentrations for the non-organic species prevented direct measurement of their DFs. However, it is inferred that during the second and third years of exposure the DF for non-organic species was at least 20. The estimated exposure time for organic iodine DF to decrease to 10 is 15 years and one year for the two installations. By combining the data for the two installations, the exposure time to reach at DF of 10 for organic iodine is estimated to be 1.75 years.

26357 (GEFR-SP—050) Modelling the time dependent nature of structural reliability. Crellin, G.L.; Ingram, G.E. (General Electric Co., Sunnyvale, Calif. (USA). Fast Breeder Reactor Dept.). 1977. Contract EY-76-C-03-0893-013. 19p. (CONF-7710108—2). Dep. NTIS, PC A02/MF A01.

From Symposium on application of reliability techniques to nuclear power plants; Vienna, Austria (10 Oct 1977).

The principles of structural reliability "stress-strength" theory are used to obtain a time dependent reliability. Constant and time dependent failure rates may then be derived. These rates are obtained in the absence of any direct time related phenomena and are the result only of interpreting the load distribution as being on the maximum load to be encountered. The failure rates are shown to be a function of the capability. As a result, whether a failure rate is constant, or time dependent, is determined by how time influences the capability. As the failure rate is a function of the capability, distributions on failure rate may be obtained through functional transforms of distributions describing the uncertainty about the capability.

26358 (SAND—77-0533C) **Relation between fuel motion and detector response for in-core fuel motion detection systems.** McDaniel, P.J.; Wright, S.A.; Scott, W.H. Jr. (Sandia Labs., Albuquerque, N.Mex. (USA); Science Applications, Inc., La Jolla, Calif. (USA)). 1977. Contract EY-76-C-04-0789. 13p. (CONF-771210—3). Dep. NTIS, PC A02/MF A01.

From Meeting on fuel and clad motion diagnostics for fast reactor safety test facilities; Los Alamos, NM, USA (5 Dec 1977).

The detection of fuel motion within test sections of reactors which have no slots (SLSF, EBR-II, SCARABEE) requires the use of an in-core fuel motion detection system. In-core systems can also be useful as auxiliary fuel motion monitoring systems for reactor facilities which do have slots. An experimental program is being conducted at Sandia to demonstrate the feasibility of in-core fuel motion detection systems. This program has two major developmental efforts. The first requires development of a suitable set of detectors, and the second requires development of analytical methods which can determine fuel motion from detector signals.

26359 Underclad cracking in nuclear vessel steels. Dolby, R.E.; Saunders, G.G. *Met. Constr. Br. Weld. J.;* 9: No. 12, 562-566(Dec 1977).

Current knowledge on the problem of underclad reheat cracking in thick walled nuclear vessels has been reviewed following a study of published and unpublished reports and discussions with experts in Europe, Scandinavia and the USA. The steels considered in the review include SA533 Grade B Class 1, SA508 Class 2, SA508 Class 3 and 22NiMoCr37.

26360 Application of acoustic emission analysis during loading of a pressure vessel by pulsating internal pressure. Bretfeld, H.; Noelker, A.; Crostack, H.A. *Materialpruefung;* 19: No. 11, 467-470(Nov 1977). (In German).

From Lecture meeting on non-destructive materials testing. Presentation, processing and critical evaluation of test results; Bremen, Germany, F.R. (16 - 18 May 1977).

Analysis of acoustic emission (frequency, pulse area) on tensile and notch bending specimens made of the pressure vessel steel; considerations on probe arrangement and test locations on the vessel; location of defects during testing the vessel under pulsating internal pressure.

26361 Improvements in or relating to power plant coolant. Shpak, V.S.; Sukhotin, A.M.; Pavlova, G.L.; Grebenik, A.M.; Nadenkova, L.S.; Lantratova, N.Y.; Nesterenko, V.B. (to AN Belorusskoj SSR, Minsk. Inst. Yadernoj Ehnergetiki). British Patent 1,489,171/A/. 19 Oct 1977. 4p.

Reference is made to the use of N_2O_4 as coolant in nuclear power plants. It has been found that when N_2O_4 circulates along the coolant circuit it accumulates metal oxides and nitrates, as well as nitrate complexes and other compounds, resulting in the transfer of metal along the circuit. This can lead to clogging of the fuel element cooling channels and possible burning out of these channels, and a transfer of activity along the circuit. Known methods of reducing such transfer usually involve trapping the metal in its different chemical forms by specially designed filters and traps. Preliminary passivation of the circuit metal may also be employed. Such measures, however, do not eliminate mass transfer of metal and radioactivity along the circuit. A coolant is here described which consists of a mixture of 97 to 99.5% N_2O_4 with 0.5 to 3% NO; it is claimed that the introduction of the NO changes the properties of the coolant so that mass transfer of metal along the circuit is reduced 70 to 100 times. A method for production of such a coolant is described.

26362 Unavailability and failure intensity of components. Caldarola, L. (Kernforschungszentrum Karlsruhe (Germany, F.R.). Inst. fuer Reaktorentwicklung). *Nucl. Eng. Des.;* 44: No. 1, 147-162(Oct 1977).

A comprehensive and standardized set of equations to calculate component unavailability and component failure intensity has been obtained in the case of the repair and inspection policies which are usually not in practice. It has been found that some of the processes describing the component behaviour can be classified under the heading of so-called 'closed chain renewal processes' which have been described in the paper. In addition a general theory for the inspected components has been developed.

26363 Steady-state stresses in concrete structures subjected to sustained and cyclically varying temperatures. England, G.L. (King's Coll., London (UK)). *Nucl. Eng. Des.;* 44: No. 1, 97-107(Oct 1977).

The state of stress in non-uniformly heated concrete structures is significantly influenced by creep. When temperatures are sustained or vary in a cyclic manner over long periods, the long term state of stress may be deduced by direct calculation and without knowledge of the previous history of stress. The long-term stress states which correspond to cyclic variations of temperature are termed steady-state-cyclic stresses to distinguish them from the steady-state stresses which relate to sustained temperatures. Theory and numerical examples are presented and it is concluded that a power dissipation formulation of the theory is appropriate for general analyses for which compatibility criteria cannot be specified in advance. Stress redistribution is less severe under cyclic conditions of temperature than when temperatures are long sustained.

26364 Foil shielded flexible conduit. Wilson, J.W. (to Superflexit Ltd., Slough (UK)). British Patent 1,486,445/A/. 21 Sep 1977. 3p.

A foil shielded flexible conduit is described that is suitable for withstanding electromagnetic interference and electromagnetic pulses and may be employed in a nuclear reactor environment. Previous attempts to manufacture such conduits have all suffered from an insufficient degree of flexibility to allow suitable installation and have been liable to breakdown in service.

26365 Guiding device for a manipulator mast for internal inspection of a reactor pressure vessel. Seifert, W.; Schlueter, H. (to Maschinenfabrik Augsburg-Nuernberg (M.A.N.) A.G., Nuernberg (Germany, F.R.)). German(FRG) Patent 2,544,009/A/. 7 Apr 1977. 19p. (In German).

A remote-controlled supporting device centering a manipulator mast is described which is mounted and operated above a reactor pressure vessel under water in such a way that rotations and vertical movements necessary for the internal inspection of the pressure vessel remain possible.

26366 Rotation-symmetrical container with insulating cover. Best, H. (to Internationale Atomreaktorbau G.m.b.H. (INTERATOM), Bergisch Gladbach (Germany, F.R.)). German(FRG) Patent 2,544,054/A/. 7 Apr 1977. 15p. (In German).

In the invention at hand a rotation-symmetrical reactor pressure vessel with an insulating cover is described which has to undergo in-service tests, a reason why it has to be wholly or partially accessible under the insulating cover.

26367 Steam turbines. Mathias, G. *Brennst.-Waerme-Kraft;* 29: No. 4, 158-160(Apr 1977). (In German).

The state of the art and the developments in steam turbines in conventional and nuclear power plants are described in a detailed bibliography.

26368 Fittings in energy engineering. Popescu, C. *Brennst.-Waerme-Kraft;* 29: No. 4, 166-168(Apr 1977). (In German).

A bibliography gives a survey of the state of the art of isolating and control valves in the field of conventionel and nuclear power plants.

26369 Screwing and holding device for lock nuts, especially for screwed joints of reactor pressure vessels. Hagen, H.G.; Scholz, M. (to Siemens A.G., Berlin (Germany, F.R.); Siemens A.G., Muenchen (Germany, F.R.)). German(FRG) Patent 2,061,037/C/. 17 Feb 1977. 5p. (In German).

A screwing and holding device for lock nuts of reactor pressure vessels is described which can be remote-controlled and will apply the forces required to unscrew the nuts. In addition, it allows unscrewing, tranporting to and from the place and screwing on again of the nuts within shorter time then all similar devices known until now.

26370 Countermeasures to prevent leakage from valve stem area. Egashira, K. (Okano Valve Mfg. Co. Ltd., Kitakyushu, Fukuoka (Japan)). *Karyoku Genshiryoku Hatsuden;* 28: No. 2, 147-152(Feb 1977). (In Japanese).

The valve stem sealing in nuclear power stations is carried out so as to make the leak as small as practically possible by the appropriate use and maintenance of gland packings and bellows. The sound bellows are the most effective means for preventing the leak from valve stems. It is basically desirable to reduce the leak from gland packings, but at the same time, it is important to facilitate the maintenance of gland packings. In the periodical inspection of LWR power stations, the proportion of the exposure accompanying the works in containment vessels is large, therefore adequate measures should be taken for servicing valves. It is complex to clarify the behavior of gland packings, therefore it is most important to make the testing machine conforming to their actual conditions. The basic attitude of valve makers should be to make valves on the reconsider-

ation for avoiding unnecessary exposure and to attach the jigs and tools required for the maintenance of valves. The comparison of asbestos packings and graphite packings was carried out, and the combined use of graphite packings with excellent sealing property and asbestos packings with low friction is recommended. Considerable dispersion is observed in the number of cycles of bellows life. The valves equipped with bellows become tall, accordingly they are limited to the valves of small size. It is necessary to test bellows with varied pressure and temperature.

26371 Application of acoustic emission techniques to integrity assessment of nuclear reactor components. Nakasa, H. (Central Research Inst. of Electric Power Industry, Tokyo (Japan)). *Karyoku Genshiryoku Hatsuden;* **28**: No. 2, 153-162(Feb 1977). (In Japanese).

Acoustic emission is the phenomenon by which elastic waves are emitted instantly by the strain energy released from the various defects in solid materials in the process from the deformation to the break. The properties and the generating state of AE signals are affected by the kinds and physical properties of materials, the kinds and amounts of various defects, external force, temperature and atmosphere. Accordingly by investigating AE characteristics, the information on the presence of defects and their dynamic behaviors can be obtained, and when plural AE detectors are used, the positions of unstable defects can be determined from the time difference of signal arrival. In nuclear power stations, AE techniques have been applied to the hydrostatic pressure tests of pressure vessels, and the continuous monitoring of whole pressure boundary systems during operation by AE method is the final target. At present, the welded parts of pipings have been monitored continuously during operation. The main basic parameters of AE characteristics are the wave form, maximum amplitude and frequency components of one AE signal, the generating frequency and energy distribution of AE signals detected with one detector, and the time difference of signals arriving at plural AE detectors. The methods of evaluating the soundness of structures by analyzing the AE parameters are explained.

26372 Vapor separator for a nuclear reactor plant. Bubenzer, O. (to Steinmueller (L. u. C.) G.m.b.H., Gummersbach (Germany, F.R.)). German(FRG) Patent 2,256,766/B/. 27 Jan 1977. 3p. (In German).

The invention concerns an improvement for vapour separators provided for nuclear reactor plant, where a degree of separation of about 10^{-8} can be achieved. The drop separators are made corrugated and are arranged together in an agglomerator, so that the drop separators open underneath into a duct, which is connected via pipes to the collecting space for waste water.

26373 Mixed-bed system with outer regeneration. Ambrus, Gy.; Koltai, P.; Sombor, A. (Villamosenergiaipari Kutato Intezet, Budapest (Hungary)). *Energ. Atomtech.;* **30**: No. 1, 18-21(1977). (In Hungarian).

An advantageous application of condensate cleaning at thermal and nuclear power plants is represented by the mixed-bed technology with outer regereration. Experimental facilities have been made of plexiglass. Operation and flowchart of the mixed-bed system are presented. Experiments have been carried out on Varion MX-KS and Varion MX-AT-660, AD, ATM, ADAM, ADM ion exchangers. The velocity vs. time diagram of separation of mixed-bed filling is illustrated. The results of the water analysis after the mixed bed of Varion ATM are: 0.05 μScm^{-1} conductivity; 4-10 μg Na/l; 10-16 μg Cl/l; 1-2 mg $KMnO_4$ consumption/l, when using the most effective connecting system.

26374 Instrumentation for the measurement of vibration in severe environments, such as nuclear reactors. Bierney, T.K. (Endevco UK Division, Herts, Eng.). pp 103-116 of Operation of instruments in adverse environments, 1976. Knight, J. (ed.). London; Institute of Physics (1977).

From Conference on the operation of instruments in adverse environments; London, UK (4 Oct 1976).

See CONF-7610120—.

The measurement of vibration and pressure (including acoustic levels) in hostile environments such as those found in generation of nuclear power presents many special problems. Transducers may be required to operate in environments composed of a combination of high temperature, high pressure, high acoustic levels, high radiation exposure and a corrosive atmosphere. These hostile environments can present a challenge to the transducer designer in terms of materials to be used and the mounting of the transducers. The challenge extends further as the transduced signal must be transmitted to monitoring equipment outside the hostile environment. The signal conditioning of transducers used at high temperature also requires careful design to obtain useful data. For example, conventional charge amplifiers may be unusable with transducers at high temperature due to the sensing element of the transducer undergoing severe changes in its characteristics. The paper discusses the types of vibration transducer for a nuclear reactor environment, the design of suitable piezoelectric transducers and the signal transmission and conditioning.

26375 Stud tensioner for opening and closing the head of a reactor pressure vessel. Schuengel, P.; Toegl, K.; Schulte, H. (to Kloeckner und Co., Duisburg (Germany, F.R.)). German(FRG) Patent 2,428,847/B/. 23 Dec 1976. 13p. (In German).

In order to reduce the hazard for the personnel while opening the reactor pressure vessel head it is proposed to use a stud tensioner facilitating not only the tightening and untightening of the head nut but also the screwing in and out of the bolt as well as its transportation from and to the place. It is provided for arranging bolt carrying units on the bearing ring supported by the closure flange greatly relieving the bolt with respect to weight. Several variants of design are proposed.

26376 Reactor coolant pump for a nuclear reactor. Burkhardt, W.; Richter, G. (to Kraftwerk Union A.G., Muelheim an der Ruhr (Germany, F.R.)). German(FRG) Patent 2,508,812/B/. 23 Dec 1976. 3p. (In German).

The invention deals with disengaging the coupling of a reactor coolant pump of a nuclear reactor feeding pressurized coolant. The disengaging coupling has two parts joined by bolts, at least one of them containing a driving agent within a bore. This is provided with a speed-depending ignition device in such manner that, if the critical speed is reached, the driving charge is ignited and the coupling is disengaged by destroying the bolts.

26377 Ultrasonic wave generator. Robinson, D.L. (to Exxon Nuclear Co., Inc., Bellevue, Wash. (USA)). German(FRG) Patent 2,617,462/A/. 25 Nov 1976. 13p. (In German).

A decive is described with the aid of which pressure vessels and similar systems, e.g. pressurized pipes and reactor cooling systems, may be inspected with regard to satisfactory quality. Without interrupting the operation of the system, the ultrasonic wave generators are brought into such a position that they pick up the acoustic signals emitted by the systems under pressure or stress. This way, an acoustic energy diagram is generated illustrating the defects which eventually may occur, thus leading to immediate warning if defects already exist in the system.

26378 Method for removing radioactive corrosion products from the inner surfaces of a nuclear reactor. Brown, W.W. (to Westinghouse Electric Corp., Pittsburgh, Pa. (USA)). German(FRG) Patent 2,617,676/A/. 18 Nov 1976. 17p. (In German).

Radioactive corrosion products may be removed from the inner surfaces of a nuclear reactor by dissolving them in the coolant which is enriched with oxygen and whose pressure is reduced. According to the invention a solution, the oxygen content of which is greater than that of water - very suitable is a H_2O_2 solution - is added to the coolant. For removing the corrosion products, the charged coolant is conducted through a demineralizer and returned to the circuit decontaminated.

26379 Process and arrangements for removing a tube from a tube plate. Savor, D.E.; Hackett, C.D.; Barger, J.J.; Blevins, M.L. (to Combustion Engineering, Inc., Windsor, Conn. (USA)). German(FRG) Patent 2,615,521/A/. 11 Nov 1976. 29p. (In German).

A process is described for removing tubes which are fixed to a plate by expansion of their ends in a friction weld (as for heat exchangers in nuclear power stations) without damaging the internal wall of the tube plate opening. It is proposed to melt at least part of the internal wall of the tube plate opening. It is proposed to melt at least part of the internal wall of the tube to be removed by a gas-tungsten arc, which is struck between an electrode and the internal tube wall, where the weld bead runs off in the shape of a screw thread. When solidifying the molten part, the tube cross section decreases because of solidification shrinkage and thermal contraction, so that the tube can easily be pulled from the plate. A suitable arrangement is described in detail.

26380 Device for welding pipes onto pressurized elements, like tube sheets, pressure vessels, headers and the like. Klein, H.; Kuhl, E.; Klippel, H.; Clemens, K. (to Steinmueller (L. u. C.) G.m.b.H., Gummersbach (Germany, F.R.)). German(FRG) Patent 2,519,876/A/. 11 Nov 1976. 9p. (In German).

A device rendering it possible to weld pipes on pressurized elements like tube sheets, pressure vessels etc. (according to patent application no. 2452598.2-24), is described. It is characterized by the centering bush forming the guidance for a welding apparatus with exchangeable welding torch for welding the root seam, consisting of the lip and the outer lip of the pipe. Additional details of the apparatus are described. The device permits satisfactory gapless through-welding of the root seam with simple engineering means.

26381 Manufacture of an interconnector. (to Bunker Ramo Corp., Oakbrook, Ill. (USA)). Netherlands Patent 7,612,458/A/. 10 Nov 1976. 10p. (In Dutch).

The fabrication of a connector as used in the core wall of nuclear reactors is described. The connector is prefabricated and an efficient way of sealing this connector leak-tight in the wall plate is found. The sealing material is glass which is melted in place. Specifications of the process are given.

26382 Pipe connection for high pressure and temperature loads. Haferkamp, D.; Hodzic, A.; Paetz, E.; Stach, H. (to Hochtemperatur-Reaktorbau G.m.b.H., Koeln (Germany, F.R.)). German(FRG) Patent 2,452,770//A/. 13 May 1976. 15p. (In German).

The patent proposes an inprovement of the clamping device for a pipe joint connecting pipelines which are subject to high pressure and temperature loads, e.g. in a nuclear power plant. This clamping device may be tightened and loosened by remote control. The proposed clamping ring consists of several segments connected with each other by hinge-type guide pins and fishplates.

26383 Experimental investigation of heat transfer in a once-through regenerator-evaporator with a chemically reacting coolant. Zdanovich, N.N.; Kolykhan, L.I.; Mikhalevich, A.A.; Nemtsev, V.A.; Nesterenko, V.B. (AN Belorusskoj SSR, Minsk. Inst. Yadernoj Ehnergetiki). *Vestsi Akad. Navuk BSSR, Ser. Fiz.-Energ. Navuk;* No. 1, 82-89(1976). (In Russian).

An experimental study is presented of heat transfer in an evaporative regenerator with chemically reacting coolant N_2O_4. A comparison is made of empirical data with computation of a 1-dimensional model; satisfactory agrement is shown.

26384 Dynamical behavior of industrial structures made of reinforced concrete. Jaudet, A. (Electricite de France, 75 - Paris). *Rev. Fr. Mec.;* No. 60, 29-52(1976). (In French).

Some tests effected by EDF in view of an experimental determination of the dynamical elasticity modulus and damping coefficient in reinforced concrete subject to working conditions similar to those for industrial structures are presented. Results given are concerned with laboratory tests on straight beams of constant section and then in-situ tests on tall chimneys, turboalternator supports, and nuclear pressure vessels. A reinforced concrete without cracks is shown to have a viscous damping from 0.25% for the straight beam up to 1.2% for the shell-type structure.

26385 Device for ultrasonic material testing of bolts having an axial through hole, preferably stud bolts of nuclear reactor pressure vessels. Hildebrandt, E.; Laurich, K.; Mueller, F. German(GDR) Patent 118,329/A/. 14 Mar 1975. 11p. (In German).

A device for ultrasonic testing of stud bolts of nuclear reactor pressure vessels is claimed. Using such a device bolts having an axial through hole do not have to be dismounted for testing.

26386 Process and device of leak testing of works, especially concrete works. Dawance, G.; Carrie, C.; Burdet, R. (to Centre Experimental de Recherches et d'Etudes du Batiment et de Travaux Publics, 75 - Paris (France)). French Patent 2,301,003/A/. 17 Feb 1975. 11p. (In French).

A procedure for testing the air tightness of the concrete containment of nuclear power plants is presented. In said invention, a local investigation procedure to be used progressively as the construction proceeds is presented. During the construction stage a plurality of conducts are arranged inside the walls of said buildings; they are connected with the outside at one end, a pressurized fluid is then injected in each conducts at the time of leak testing and said fluid behavior is observed in view of detecting and leakage.

FUEL ELEMENTS

26387 Application of finite element method to ring compression test. Yamada, R.; Suzuki, M.; Harayama, Y. (Japan Atomic Energy Research Inst., Tokai, Ibaraki. Tokai Research Establishment). *Nucl. Eng. Des.;* **44**: No. 1, 75-85(Oct 1977).

The relation between deflection and load during the ring compression test used to study mechanical properties of a fuel cladding tube is examined by a computer program which deals with the elasto-plastic deformation by the two-dimensional finite element method. Under Hill's criterion, in the early stage of ring deformation the results calculated by the plane strain condition, and in the late stage the results calculated by the plane stress condition, agree well with the experimental ones. It is revealed that plastic deformation occurs even at the initial stage of the test, and crack locations are suggested. The relation between the ring compression test and the uniaxial tension test are also discussed.

26388 Experience with a new ultrasonic inspection system for non-destructive examination of precision tubes. Gundtoft, H.E.; Nielsen, T.; Agerup, C.C. *Materialpruefung;* **19**: No. 9, 385-388(Sep 1977). (In German).

From Lecture meeting on non-destructive materials testing. Presentation, processing and critical evaluation of test results; Bremen, Germany, F.R. (16 - 18 May 1977).

One of the components of the tube inspection system for flan detection and dimension measurement is a computer which controls a sorting plant, so that control may be fully automatic. This contribution describes the experiences and improvements which during the last few years have led to a system which is stable and sufficiently accurate so as to meet the rigid specification requirements in dimension and flan control of precision tubes. In standard inspection of cladding tubes this means that the whole control process, for flaws as well as dimensions may be carried out at a velocity of 6 m tube/min.

26389 Device for dismounting fuel elements. Jabsen, F.S. (to Babcock and Wilcox Co., New York (USA)). German(FRG) Patent 2,462,455/A/. 8 Jun 1977. 21p. (In German).

A device is made permitting to dismount simultaneously several fuel rods from a nuclear reactor fuel element. The clamping device is described, as well as the method to release the holding forces between spaces and fuel rods in order to be able to withdraw the rods.

26390 Neutron radiography experiments at JRR-4, (2). Neutron radiography of simulated mixed-oxide fuels. Sato, O.; Matsumoto, G. (Nagoya Univ. (Japan). Faculty of Engineering). *J. Nucl. Sci. Technol. (Tokyo);* **14**: No. 4, 300-307(Apr 1977).

Experiments have been performed at JRR-4 (Japan Research Reactor) to investigate the capability of neutron radiographic techniques in applying to the nondestructive inspection of UO_2-PuO_2 mixed-oxide fuels. The object of the inspection was to detect "Pu particles" in the mixed-oxide fuels. In place of the actual fuel, two stages of TiO_2-Eu_2O_3 mixed-oxide fuel dummy samples (the 1st stage for preliminary experiments and the 2nd stage for simulating the ATR fuel) were fabricated and radiographed with the direct exposure method using a Gd converter screen and high resolution films. Neutron radiographs of the 1st stage dummy samples showed the excellent capability of the detection technique. Those of the 2nd stage dummy samples, however, revealed the detection limit of the technique, which showed that the present technique had not enough capability to satisfy the requirements in the inspection and that improvements of the detection technique especially on the contrast should be accomplished.

26391 Rod-shaped fuel element for nuclear reactors. Schneider, G. (to Nuklear-Chemie und -Metallurgie G.m.b.H. (NUKEM), Hanau (Germany, F.R.)). German(FRG) Patent 1,614,308/C/. 23 Dec 1976. 7p. (In German).

The invention concerns the axial fixation of the fuel stringer of rod-shaped nuclear reactor fuel elements in the cladding tubes. It is proposed to replace the springs used until now for fixation by bimetal clamping elements. These are selected and arranged in such a way that the press fit in the cladding tube will be compensated by heating and the clamping ring is easily displaceable. Variations of the shaping of the bimetal strips are described.

26392 Method and device for inserting a multitude of fuel rods into a fuel element frame. Tindale, J.B.; Burgess, J.H. (to UKAEA London Office). German(FRG) Patent 1,764,925/B/. 16 Dec 1976. 13p. (In German).

A method is described to insert a number of fuel rods into a fuel element frame with spacer grids forming planes lying one over the other. With the aid of the device according to the invention, so-called pilot rods are inserted which have a smaller diameter than the fuel rods. Their rear end is shaped so that the front end of the fuel rod can be easily embraced. The fuel rods are guided by grooved pairs of rollers; they are drawn into the fuel element frame instead of the pilot rods. Constructional details are presented.

26393 Procedure for drying humidity-containing bodies. Johnson, C.R. (to Babcock and Wilcox Co.). German(FRG) Patent 2,616,369/A/. 18 Nov 1976. 13p. (In German).

The invention concerns a decontamination process for extracting impurities, in particular humidity and gases, from nuclear fuel rods before they are sealed and inserted into the reactor. The fuel rod, which has a small drilling hole, is placed in a low pressure container. The container is filled with a liquid drying agent which washes out the impurities. A dry inert gas (nitrogen, noble gases) is used for rinsing. Alcohols, ketones, methanol, acetone are named as drying agents.

26394 Improved support for nuclear fuel rods. Smith, B.A.; Brayman, K.W.; Pillow, N.W. (to General Electric Co., Schenectady, N.Y. (USA)). German(FRG) Patent 2,618,837/A/. 11 Nov 1976. 17p. (In German).

In order to prevent the accumulation of impurities between the end plug of a fuel element and the support plate for the total fuel element cluster, it is proposed to fit fins or grooves to the end plugs or the support plate, through which the coolant may flow and thereby wash away accumulations of impurities, which in the most unfavorable case might clog this space. If necessary, the support plate contains an opening facilitating the flowing off.

26395 Nuclear reactor fuel element. Jabsen, F.S. (to Babcock and Wilcox Co., New York (USA)). German(FRG) Patent 2,100,501/C/. 11 Nov 1976. 9p. (In German).

An improvement of the type of suspension of nuclear reactor fuel elements supported by an upper and a lower grid structure is described. In the upper grid, a number of T-shaped grooves are provided, while the fuel rods at the upper end have T-shaped parts with which they are suspended on the nuts. The support at the lower end, too, is facilitated by projecting plugs on the fuel rod, inserted into corresponding recesses of the lower grid.

26396 Nuclear fuel element and method for its production. Miertschin, G.N.; Powell, K.F. (to General Atomic Co., San Diego, Calif. (USA)). German(FRG) Patent 2,614,677/A/. 21 Oct 1976. 13p. (In German).

An improvement of the construction of nuclear fuel elements consisting of a graphite block in which the nuclear fuel is arranged in cylindrical bores is suggested in order to counteract the difficulties arising due to tensile stresses. According to the invention, the nuclear fuel rods in the borings are to each be divided into sections between which spacers are placed. The borings are closed by stoppers.

26397 Method for the fabrication of a fuel body from an agglomerate of fuel particles. Redding, G.B. (to Commission of the European Communities, Brussels (Belgium)). German(FRG) Patent 1,589,752/B/. 14 Oct 1976. 1p. (In German).

The suggestion deals with the form of coating of a synthetic resin on nuclear fuel particles already having a fission product inhibiting coating. The resin forms a fuel body from the particles. It is proposed to fill a hollow form with nuclear fuel particles, to then pour in liquid synthetic resin and to pour it off again so that only the resin retained by the surface tension remains on the particles. The mass is then solidified by heat treatment. A high packing density is achieved.

26398 Spacer for nuclear reactor fuel rods. Brayman, K.W. George, D.K.; Rawlings, J.C.; Dix, G.E. (to General Electric Co., Schenectady, N.Y. (USA)). German(FRG) Patent 2,609,120/A/. 16 Sep 1976. 13p. (In German).

In the fuel rod clusters of nuclear reactors the flow pressure of the coolant may cause a displacement of the geometrical position of single fuel rods. Now a spacer is proposed fixing at least the four corner fuel rods within the annular flow channel of a nuclear reactor. This spacer has a supporting part comprising four lateral ties connected by four corner ties, thus forming a uniform rigid structure. At the end of each lateral tie an L-shaped fin is mounted which on the one hand serves to fix the corner fuel rods and on the other to guide the coolant flow.

26399 Cell-shaped fuel element spacer grid construction. Jabsen, F.S. (to Babcock and Wilcox Co., New York (USA)). German(FRG) Patent 2,550,932/A/. 2 Sep 1976. 13p. (In German).

The invention deals with a method and a device to invest and remove fuel rods from fuel element spacer grid constructions, where the intactness of the outer surfaces of the fuel rods is guaranteed. To insert a fuel rod, according to the invention, a rod is inserted into the proper cell where it is turned, thereby bending the inelastic spacer grids projecting into the cell from their former position. When the fuel element is properly inserted, they return to their former position. The cell-shaped spacer grid construction forms rows of aligned slots through which the rods may be inserted or removed.

26400 Spacers for fuel elements with a large number of fuel rods. Christ, R.; Christiansen, U. (to Nuklear-Chemie und -Metallurgie G.m.b.H. (NUKEM), Hanau (Germany, F.R.)). German(FRG) Patent 1,764,185/B/. 8 Jul 1976. 4p. (In German).

This addition to German Patent 15 64 434.5, like the main Patent, ensures the stable non-vibrating position of a large number of fuel rods which comprise fuel elements. The holding device of square tube sections, which have spiral springs on each side of the square and are arranged between 4 fuel rods, is simplified, and the number of tube sections and the mass absorption crossection is reduced. Also the necessity for a soldered or welded connection between the grid made of zirconium alloy and the square tube sections with the heat resisting chromium nickel material spiral springs is avoided. This is made possible by suspending the square tube section by wires taken through holes in these supports, which are soldered or welded with the same material as the grid. To prevent vibration of the relatively long fuel rods, the spacers (consisting of the square tube sections supported by grids) are distributed in several planes along the length of the rods. In these planes, there are always 4 fuel rods under pressure of the spiral springs of the tube section enclosed by the fuel rods. The bulges or projections in the grids in order to form a counter force to this pressure are also distributed over the whole length of the rod, but lie in somewhat higher planes than the spring forces.

26401 Fuel element. Gordon, G.M.; Cowan, R.L. II. (to General Electric Co., Schenectady, N.Y. (USA)). German(FRG) Patent 2,549,969/A/. 13 May 1976. 21p. (In German).

A suggestion is made to improve fuel elements for nuclear reactors by coating the metal jacket (e.g. of zirconium alloy) surrounding the fuel core with two different metal layers where the first protects against diffusion and the second protects the jacket against fission products and corrosive gases. Chromium or a chromium alloy is suggested as the first layer, copper, nickel or iron as the second. The design according to the invention is to increase the safety against damaging.

26402 Fuel element. Gordon, G.M.; Cowan, R.L. II. (to General Electric Co., Schenectady, N.Y. (USA)). German(FRG) Patent 2,550,028/A/. 13 May 1976. 17p. (In German).

A fuel element for nuclear reactors is proposed, which has a long life, as it has reduced sensitivity to corrosion, cracking and damage due to swelling of the nuclear fuel. The nuclear fuel is surrounded by a metallic layer of stainless steel or copper or nickel or their alloys. The fuel element can (made of zirconium alloy) has a chromium or chromium alloy layer on the inside, which should protect it against the diffusion of damaging particles. The nuclear fuels mentioned are uranium, plutonium or thorium compounds.

26403 Fuel rod bundles for nuclear reactors. Lass, J.L.; Venier, D.A. (to General Electric Co., Schenectady, N.Y. (USA)). German(FRG) Patent 1,589,867/C/. 8 Apr 1976. 13p. (In German).

The invention deals with an improvement of the construction of fuel clusters in nuclear reactors consisting of numerous rods. One wants to prevent that the spacer rods twist against each other, while the upper grid plate must be easy to release and to fasten should the necessity arise. The technical details of the catch and fastening are described in great detail.

26404 Calculation of the temperature field in a fuel element with a rod core and a peeling sheath. Korsun, A.S.; Kudrova, L.G.; Petrovichev, V.I. *Vopr. Teplofiz. Yad. Reakt.;* No. 2, 9-13(1976). (In Russian).

The problem of steady-state heat conduction is solved for cylindrical fuel elements where the conductivity of the thermal contact between sheath and core is a function of the angle. The solution is found by the Fourier m method. For determining the Fourier coefficients, the infinite system of equations is replaced by a finite one and the latter solved by iterations. The temperature field in the core and in the sheath is now calculated for the case of a step variation of the thermal conductivity around the circumference (with the sheath peeling angle varied from 20° to 120°). Data are shown on the effect of the peeling angle on the maximum core temperature and its radial coordinate.

CONTROL SYSTEMS

26405 (COO—2245-47TR) **Analysis of the thermal-hydraulic behavior in the CRBR secondary control assembly, including interassembly heat transfer effects.** Basehore, K.L.; Todreas, N.E. (Massachusetts Inst. of Tech., Cambridge (USA). Dept. of Nuclear Engineering). Jul 1977. Contract EY-76-S-02-2245. 173p. Dep. NTIS, PC A08/MF A01.

Portions of document are illegible.

A first effort is presented at modeling the thermal hydraulic behavior of the CRBR secondary control assembly (SCA). For modeling purposes, the SCA is broken into two sections, the counterflow section and the poison control section, which contains the control bundle. The coolant temperature distribution in the counterflow section is evaluated by using a semianalytical solution technique. The distribution in the poison control section is found by using forward differenced numerical techniques. The wire wrap sweeping in the control bundle is represented by an empirical enhanced eddy diffusion of heat as in the ENERGY model

26406 Applying improved instrumentation and computer control systems. Bevilacqua, F.; Myers, J.E. *Nucl. Eng. Int.;* **22**: No. 265, 48-51(Dec 1977).

In-core and out-of-core instrumentation systems for the Cherokee-I reactor are described. The reactor has 61m-core instrument assemblies. Continuous computer monitoring and processing of data from over 300 fixed detectors will be used to improve the manoeuvering of core power. The plant protection system is a standard package for the Combustion Engineering System 80, consisting of two independent systems, the reactor protection system and the engineering safety features activation system, both of which are designed to meet NRC, ANS and IEEE design criteria or standards. The plants protection system has its own computer which provides plant monitoring, alarming, logging and performance calculations.

26407 Material for shutting down gas cooled nuclear reactors. Jackson, F. (to British Nuclear Fuels Ltd., Risley). British Patent 1,482,750/A/. 10 Aug 1977. 5p.

Some disadvantage of conventional emergency shutdown means for nuclear reactors employing a supply of B steel shot or B powder are mentioned. With regard to B powder it is stated that there is some uncertainty as to whether the powder once dispersed into the core will settle in the active part of the core in sufficient quantities to ensure shutdown. The system described aims to avoid these disadvantages. Pellets are provided comprising a solid neutron poison material and a solid organic substance that remains solid at the relatively low temperature normally expected to prevail in the reactor coolant channel away from the reactor core. The organic substance melts at a higher temperature expected to prevail in the coolant channel within the core., and is adherent on melting to the coolant channel wall and to the solid neutron poison, being thus capable of causing adherence of the latter to the coolant channel wall in the reactor core. The pellets are preferably given a moisture resistant coating to prevent them sticking together and to impart free flowing characteristics. The neutron poison may consist of B, Cd, Gd, or their compounds, and for the coating a suitable polymer may be used. Steel filings may be incorporated in the pellets to aid easy flowing under gravity. Examples of manufacture of the pellets are given.

26408 Experiments in connection with control of boron acid concentration by ion exchange in Hungary. Nagy, O.; Szabo, J. (Villamosenergiaipari Kutato Intezet, Budapest (Hungary)). *Energ. Atomtech.;* **30**: No. 1, 8-13(1977). (In Hungarian).

The results obtained with an experimental nuclear power plant output control with boron acid ion exchange technology are presented. The dependence of the ability of the ion exchanger to bind boron acid on the concentration of the boron acid solution, the temperature and the degree of the alkalinity of the resin has been studied. The results obtained for Hungarian resins are compared with those for some Duolite-type ones. Some results for a control system realized in big laboratory size are outlined.

26409 Control rod drives for nuclear reactors. Matthews, J.C. (to Diamond Power Specialty Corp., Lancaster, Ohio (USA)). German(FRG) Patent 2,605,534/A/. 30 Dec 1976. 17p. (In German).

The invention is to avoid the control road drive of a nuclear reactor being ejected in case of the pressure vessel, which contains the control rod drive, bursting. This is of particular importance in case of a scram. A proposal is made to fix a catch which is to grip and to lock the lead screw. Variants of the device are described.

26410 Device for measuring the position of control rods in nuclear reactors. Hanna, I.; Kaiser, G. (to Hochtemperatur-Reaktorbau G.m.b.H., Koeln (Germany, F.R.)). German(FRG) Patent 2,521,340/A/. 25 Nov 1976. 17p. (In German).

The invention solves the task to design the measurement of the position of control rods by means of a permanent magnet and a number of reed contacts to be operated by the magnet in such manner that it may also be carried out under the conditions and temperatures existing in a high-temperature reactor. The reed contacts are placed within discs made of magnetically conductive material and their contact tongues are coated with rhodium. Technical particulars are explained in detail.

26411 Device for damping the control rod drive of a nuclear reactor. Matthews, J.C. (to Diamond Power Specialty Corp., Lancaster, Ohio (USA)). German(FRG) Patent 2,619,158/A/. 18 Nov 1976. 21p. (In German).

In order to be able to slow down the dropping velocity of control rods, intended for the shut-down of a nuclear reactor, it is proposed to arrange the damping device near the connection part of the lead screw so that it always is situated within the nuclear reactor, filled with liquid, and the probability of a dry scram becomes very small. The lead screw is enclosed by a casing on which a damping device is mounted which is described in detail.

ENVIRONMENTAL ASPECTS

REFER ALSO TO CITATION(S) 26871, 26985, 26992

26412 (EPRI-NP—604) Validity and design of environmental surveillance systems for operating nuclear power plants. Final report. Eichholz, G.G. (Georgia Inst. of Tech., Atlanta (USA). School of Nuclear Engineering). Dec 1977. 98p. Dep. NTIS, PC A05/MF A01.

The composition and procedures of environmental surveillance programs at completed and operating nuclear power plants have been examined with respect to their validity, continuing significance and cost. It was found that many programs contain components that are mainly an extension of preoperational baseline measurements that need not be continued indefinitely and that others lack the statistical validity to make their continued application meaningful. To identify the practical limits imposed by counting statistics and realistic equipment capacity measurements were done on iodine-131 and cesium-137 containing samples to establish detectability limits and proportionate costs for sample preparation and counting. It was found that under commercial conditions effective detectability limits and expected confidence limits were substantially higher than those mentioned in NRC Regulatory Guides. This imposes a need for either selecting fewer samples and counting them for longer times or accepting a lesser accuracy on more samples, within the bounds of reasonable cost per sample.

26413 (USGS-CIRC—745) Water consumption by nuclear powerplants and some hydrological implications. Giusti, E.V.; Meyer, E.L. (Geological Survey, Washington, D.C. (USA)). 1977. 14p. Geological Survey, Arlington, VA.

About 63 percent of the energy input to a nuclear powerplant is discharged as heat to the cooling water system. Published data show that estimated water consumption varies with the cooling system adopted, being least in once-through cooling (about 18 cubic feet per second per 1,000 MWe) and greatest in closed cooling with mechanical draft towers (about 30 cubic feet per second per 1,000 MWe). When fresh water is used, this large variation carries important implications to the regional water resources economy in view of the increasingly keen competition for water. Thus it is felt that there is an urgent need to verify these findings with measurements. The critical need for cooling water at all times by the nuclear powerplant industry, coupled with the knowledge that water withdrawal in the basin will generally increase with time and will be at a maximum during low-flow periods, indicates a need for reexamination of the design low-flow currently adopted and the methods used to estimate it. In particular, there is a need to develop models that account and evaluate low flows in terms of the ground-water inflow to the river basin network, the evapotranspiration from the basin, and the basin-wide water consumption by man. The amount of power generated, the name of the cooling water source, and the cooling method adopted for all nuclear powerplants projected to be in operation by 1985 in the U.S. are tabulated, and the estimated annual evaporation at each powerplant site is shown on a map of the continuous U.S. Another map is presented that shows all nuclear powerplants located on river sites as well as stream reaches in the U.S. where the 7-day, 10-year low flow is at least 300 cubic feet per second or where this amount of flow can be developed with storage.

26414 Selecting sites for ease of licensing requirements. Blackmon, D.B. *Nucl. Eng. Int.;* **22**: No. 265, 51-54(Dec 1977).

Procedures for site selection for the PWR stations Cherokee and Perkins are considered. Environmental licensing requirements for both stations, which are under different regulatory bodies, are described. The progress made in the NRC environmental licensing for each station is described in a chronology of the main stages.

26415 Nuclear power in western society. Franklin, N.L. (Nuclear Power Co. (Risley) Ltd. (UK)). *J. Br. Nucl. Energy Soc.;* **16**: No. 4, 303-314(Oct 1977).

The degree to which problems of public acceptance have contributed to the slowdown in progress of nuclear power in Western European countries and the USA is discussed. Some of the effects on the nuclear power industry, i.e. the electrical utilities, the power station suppliers, and the fuel cycle contractors are described. The problem of the lack of public acceptance is examined by consideration of four areas: the position of the employee working in nuclear installations, opposition from the local community, the question of terrorism and its impact on nuclear policy, and finally, what is felt to constitute the greatest anxiety concerning nuclear power, that of proliferation.

26416 Risk assessment and the social response to nuclear power. Otway, H.J. (International Atomic Energy Agency, Vienna (Austria)). *J. Br. Nucl. Energy Soc.;* **16**: No. 4, 327-333(Oct 1977).

A theoretical framework for risk assessment studies is presented. Methodologies from various disciplines can be used within this framework to allow a scientific approach to the understanding of complex interactions between technological and social systems. A pilot application of an attitude-formation model to examine the underlying determinants of groups for and against nuclear power is summarized.

26417 Nuclear put into questions. *Rev. Gen. Nucl.;* 1-149(Jul 1977). (In French).

This paper is a French translation published by the American Nuclear Society (ANS) under the title 'Nuclear Power and the environment - Questions and answers'. Some data special to United States have been transposed, precised and refined in view of the French context. Three chapters appear: the questions asked, responses from ANS specialists, and comments prepared by French specialists on request from the Societe Francaise d'Energie Nucleaire (SFEN).

26418 Some characteristics of the first Polish atomic power station relating to its effect on the environment. Konieczko, A. *Postepy Fiz. Med.;* **10**: No. 1, 41-49(1975). (In Polish).

From 1. national seminar on environment and population protection around nuclear installations; Warsaw, Poland (16 Dec 1974).

The paper discusses the effect of the first Polish atomic power station on the environment resulting from the emission of the radioactive gaseous wastes to the atmosphere during normal operation and/or pre-determined failure. The results are also presented of the expulsion of the heated water to the Zarnowieckie lake and of the side effect of the construction of the power station on the area surrounding it.

SITING

REFER ALSO TO CITATION(S) 26783

RADIOACTIVE EFFLUENTS

REFER ALSO TO CITATION(S) 25924, 25929

26419 Population hazards associated with fossil fuel and nuclear power production. Jaworowski, Z. (Centralne Lab. Ochrony Radiologicznej, Warsaw (Poland)). *Postepy Fiz. Med.;* **10**: No. 1, 149-154(1975). (In Polish).

From 1. national seminar on environment and population protection around nuclear installations; Warsaw, Poland (16 Dec 1974).

The additional number of deaths has been estimated in the population neighbouring an atomic power station (1000 MWe) as compared with a coal power station of the same power output, caused by the dissipation of natural and artificial radionuclides, sulphur dioxide and dust into the atmosphere. The non-radiation hazard from a thermal power station was found to be about 6 orders of magnitude higher than the radiation hazard from a PWR-type atomic power station. The hazard due to radium-226 dissipated by power stations running on coal are several hundred times higher than that due to radioactive noble gases and iodine-131 dissipated by PWR-type atomic power stations.

CHEMICAL AND THERMAL EFFLUENTS

26420 Agricultural use of heat discharge by nuclear power plants. Grauby, A.; Delmas, J.; Foulquier, L.; Guillermin, R. (CEA Centre d'Etudes Nucleaires de Cadarache, 13 - Saint-Paul-les-Durance (France). Service d'Etudes et Recherches sur l'Environnement). *Bull. Inf. Sci. Tech. (Paris);* No. 222, 1977(1977). (In French).

At a time in which energy savings are of prime importance, it is interesting to be able to offer a technique enabling the use of the heated waters leaving the cooling circuits of electric power plants. Satisfactory and positive results have been obtained by the Environmental Research Service, in the area of open field farming as well as in pisciculture. The use of a network of buried pipes conveying the hot water leads to greater crop yields, off-season scheduling of early and late varieties to benefit from favorable market prices, together with the possibility of adapting priority industrial crops such as soya to our climates.

RESEARCH, TEST, AND EXPERIMENTAL REACTORS

REFER ALSO TO CITATION(S) 26301, 26436, 26470

26421 (ANL/SAREF—75-1) **SAREF Project. Volume I. Conceptual design report.** (Argonne National Lab., Ill. (USA)). Dec 1975. Contract W-31-109-ENG-38. 168p. Dep. NTIS, PC A08/MF A01.

The Safety Research Experiment Facility Concept is introduced, a brief description of the site and overall plant facilities is provided followed by a description of facility systems. The design requirements and criteria used to guide the conceptual design effort are discussed. The operational safety features of this facility are addressed to scope limiting operating conditions at the outset. The cost estimates developed for this design are summarized along with the corresponding construction schedule. Finally, decommissioning of this facility, at the end of its useful life, is considered.

26422 (ORNL/TM—5999) **Technical specifications for the Oak Ridge Research Reactor.** (Oak Ridge National Lab., Tenn. (USA)). Jan 1978. Contract W-7405-ENG-26. 58p. Dep. NTIS, PC A04/MF A01.

The following sections are included: (1) glossary of terms, (2) safety limits and limiting safety system settings, (3) limiting conditions for operation, (4) surveillance requirements, (5) design features, and (6) administrative controls. (DG)

26423 (ORNL/TM—6200) **Oak Ridge Research Reactor quarterly report, April, May, and June of 1977.** Hurt, S.S. III; Lance, E.D. (Oak Ridge National Lab., Tenn. (USA)). Jan 1978. Contract W-7405-ENG-26. 36p. Dep. NTIS, PC A03/MF A01.

The ORR operated at an average power level of 29.8 MW for 28.2 percent of the time during April, May, and June of 1977. Ten fuel elements were declared spent (56.0 percent burnup) during the quarter, while eight new elements were placed in service. Two shim-rod elements were retired from service at an average burnup of 72.0 percent. The reactor was shut down on twelve occasions, one of which was unscheduled. Reactor downtime needed for refueling, maintenance and checks was quite low, with the reactor remaining available for operation 85.0 percent of the time. Maintenance activities, both mechanical and instrument, were essentially routine in nature. In-service inspections completed during the quarter included examination of welds in the reactor vessel on June 2, 1977, and inspection of pipe welds in the ORR in June 1977.

26424 (SAND—77-1807) **Annular core pulse reactor upgrade. Quarterly report, July—September 1977.** (Sandia Labs., Albuquerque, N.Mex. (USA)). Dec 1977. Contract EY-76-C-04-0789. 31p. (NUREG—0120-4). Dep. NTIS, PC A03/MF A01.

The object of the ACPR Upgrade is to arrive at a reactor modification which will provide an increased pulsed neutron fluence in the irradiation cavity without an excessive degradation of the pulse duration. The upgraded reactor will also have an increased steady-state neutron flux. The initial approach to the upgrade modification involved a two-region core concept. The inner region, surrounding the irradiation cavity, consisted of a high-heat-capacity fuel capable of sustaining a large fission energy deposition. The outer region consisted of a uranium-zirconium hydride fuel similar to the present ACPR fuel. During a previous quarter, the high-heat-capacity fuel was chosen as $BeO—UO_2$ and in-pile tests were conducted with $U—ZrH_{1.5}$ samples. Posttest examination of the hydride samples indicated that further fuel development would be required for the U—ZrH fuel. Since such development was not feasible due to schedule and budget considerations, calculations were performed for a core consisting entirely of $BeO—UO_2$ fuel elements. These results indicated that an all $BeO—UO_2$ core would produce a greater improvement for the ACPR Upgrade than a two-region, $BeO—UO_2$ and ZrH core. Hence, the decision was made to utilize sa single-region core of $BeO—UO_2$ fuel elements. Progress is summarized in the following task areas: (1) safety, documentation, and compliance; (2) core nuclear design; (3) console development; (4) mechanical design; (5) fuel element design; (6) primary fuel material studies; (7) secondary fuel material studies; (8) driver core fuel element; and (9) diagnostic system. A project schedule is included. (DG)

26425 New nuclear reactor being designed. *J. Interdiscip. Cycle Res.;* **49**: No. 26, 10-11(4 Nov 1977).

The Australian Atomic Energy Commission has started design work for a new nuclear reactor to meet national radioisotope production and research needs. The existing HIFAR reactor which has been operating for 19 years is becoming obsolete in its technology with advancing age. A conceptual design for a medium powered open-pool reactor, based in part on German technical developments, has been prepared. It is expected that design of the fuel elements will be fixed in mid 1978, enabling work to start on the design of heat transport system, building, ventilation, instrumentation and control systems.

26426 Space propulsion system for terrestrial electricity. Marshall, P. *Nucl. Eng. Int.;* **22**: No. 262, 44-45(Sep 1977).

The concept of the gaseous fuel reactor is briefly examined. Still in the fundamental research stage, the concept is of interest as a non-proliferation alternative nuclear system. In a mock-up reactor at Los Alamos tests are in progress using uranium hexafluoride gas.

26427 Modification of reactor (reactor safety research facility) in Tokai Research Establishment of Japan Atomic Energy Research Institute (report). *Genshiryoku Iinkai Geppo;* **21**: No. 11, 17-19(Feb 1977). (In Japanese).

A report of the Committee on Examination of Reactor Safety to the Atomic Energy Commission of Japan concerning the modification of a reactor (reactor safety research facility) is described. The modification is related to irradiation capsules, i.e. addition to the kinds of capsules, the method of strength design, and the heating value of the test fuel; and the reactivity control capability of the control rods. The safety of the modification was confirmed.

26428 Experimental water-water reactor. Goncharov, V.V.; Egorenkov, P.M.; Arkhangel'skii, N.V.; Shavrov, P.I.; Buslaev, V.S.; Karachinskii, V.F. USSR Patent 428,353/A/. 25 Feb 1975. 4p. (In Russian).

A water-cooled and water-moderated research reactor is described which accomodates the vessel, the core with distantioning

lattice with a removable insert, platform for fastening operating channels as well as channels of control and shield systems. Changeable cleats and distribution stancheons with rollers are arranged on the platform so as to improve experimental capacities of the reactor.

PROPULSION REACTORS

REFER ALSO TO CITATION(S) 26426

26429 **Future of nuclear propulsion in merchant ships.** Young, R.T. (American Bureau of Shipping (USA)). *Schmierungstechnik;* **44**: No. 22, 694-697(28 Oct 1977).

Attention is paid to a number of issues which must be resolved before any firm commitment to build a commercial nuclear powered ship will be made. Basically, these can be grouped into three major problem areas: first, economic; second, indemnification and liability; and third, port entry and international clearance. It is concluded that there is reason for guarded optimism, as concerted efforts to solve the important issues are now underway. Some examples are briefly discussed.

REACTOR SAFETY

REFER ALSO TO CITATION(S) 26312

26430 (AD-A—042219) **Structural integrity of water reactor pressure boundary components. Progress report for period ending 28 February 1977.** Loss, F.J. (Naval Research Lab., Washington, D.C. (USA)). May 1977. Contract AT(49-24)-0207. 58p. NTIS PC A04/MF A01.

This report describes research progress in a continuing program to characterize materials properties performance with respect to structural integrity of light water reactor pressure boundary components. Progress for this reporting period is summarized in the following areas: (a) Radiation embrittlement resistance of A533-B Class 1 steel plate as a function of extra low copper impurity content (b) Influence of phosphorus and copper content on post-irradiation upper shelf toughness and postirradiation toughness recovery for A533-B steel plate and weld metal (c) Investigations of warm prestress and plastic net ligament phenomena as a means to mitigate crack extension in a vessel during a loss of coolant accident (d) Evaluation of critical factors in crack growth rate studies in a pressurized water reactor environment.

26431 (ANL—77-44) **Summary and evaluation of fuel dynamics transient-overpower experiments: status 1974.** Deitrich, L.W.; Doerner, R.C.; Hughes, T.H.; Wright, A.E. (Argonne National Lab., Ill. (USA)). Jun 1977. Contract W-31-109-ENG-38. 128p. Dep. NTIS, PC A07/MF A01.

The report summarizes and evaluates experiments conducted in the Transient Reactor Test Facility (TREAT) using the Mark-II loop facility. The tests discussed are of the E and H series. Detailed descriptions of test conditions and test results as of February 1974 are presented. Since all data have not been acquired on all experiments, this report must be considered interim in nature. Particular emphasis is placed on data relevant to Fast Test Reactor (FTR) safety-analysis efforts.

26432 (ANL—77-54) **Final report on TREAT Test R3, a single-pin loss-of-flow experiment.** Holtz, R.E.; Grolmes, M.A.; Spencer, B.W.; Miller, C.E.; Kramer, N.A.; Testa, F.J.; Murphy, W.F. (Argonne National Lab., Ill. (USA)). Jul 1977. Contract W-31-109-ENG-38. 57p. Dep. NTIS, PC A04/MF A01.

Test R3 was the first of the R-series fuel-element meltdown tests performed to support modeling and code development for analysis of hypothetical, whole-core accidents in LMFBR's. Test R3 served as a proof test for the subsequent R4—R8 sequence of seven-pin tests examining coolant, cladding, and fuel behavior under thermal and hydraulic conditions representative of a hypothetical loss-of-coolant flow (LOF) with failure to scram in FFTF. The high heat loss radiated from the single test fuel element run at full power prevented representative prototypicality of the test events. However, the test was significant as a prelude to subsequent seven-pin tests, and also from the standpoint of materials interactions and fuel-motion detection by the hodoscope. Coolant voiding began when the inlet flow rate was down to about 1.7 m/s (approximately 22% of initial flow rate). Upon melting, most of the cladding moved downward, eventually solidifying in the bottom of the test region, forming an inlet blockage. For the conditions of this single-pin test, molten-cladding flooding and upper blockage formation were not found. Subsequent fuel melting was relatively minor; pellets at the top and bottom of the active fuel showed no melting, while about 43% area melting occurred at the hot spot. At no time during the meltdown sequence was there any sodium reentry or significant pressurization events.

26433 (CENPD—252-NP) **Method for the analysis of blowdown induced forces in a reactor vessel.** (Combustion Engineering, Inc., Windsor, Conn. (USA)). Dec 1977. 245p. Engineering, Inc., Windsor, CT.

The Combustion Engineering methodology for the prediction of the reactor pressure vessel pressure and blow distributions during the subcooled and early saturated portion of the blowdown period of a loss-of-coolant-accident is described. The analysis employs the CEFLASH-4B computer program. (CEFLASH-4B is the CEFLASH-4A code with several subroutines deleted to provide increased nodes and flowpaths. The CEFLASH-4A Computer Program has been approved by the NRC for use in Appendix K analyses.) The specific use of the CEFLASH-4B procedures for blowdown loads analysis is supported by analytical comparisons with results from the large scale LOFT L1-2 experimental blowdown and CEFLASH-4B model parametric studies. Results for a typical application of this methodology to a loss-of-coolant-accident with mechanistically determined pipe breaks for the Combustion Engineering standard 3800 Mwt plants are presented.

26434 (GA-A—14592) **Status of the General Atomic HTGR core seismic verification program.** Wesley, D.A. (General Atomic Co., San Diego, Calif. (USA)). Dec 1977. Contract EY-76-C-03-0167-051. 31p. (CONF-770729—13). Dep. NTIS, PC A03/MF A01.

From Symposium on instrumentation and control for fossil demonstration plants; Chicago, IL, USA (13 Jul 1977).

Special purpose computer programs have been completed which characterize the dynamic response of the HTGR core to seismic motion. These programs have been correlated with experimental results from a variety of scale model tests to confirm the capabilities of analytical methods. In conjunction with the analytical and experimental efforts required to determine the loads within the core, a parallel test program to ascertain the seismic strength allowables of the core components has been conducted. Finally, analytical methods have been developed to compute the impact stresses developed within the components which may then be combined with secondary stresses resulting from thermal and irradiation effects. Although the core seismic program is not yet complete, an in-depth understanding of the dynamic behavior has been obtained, and the capability now exists to evaluate the seismic capacity of the HTGR core.

26435 (GEFR-SP—049) **Structural reliability methodology: application at the system level.** Ingram, G.E.; Herrmann, C.R. (General Electric Co., Sunnyvale, Calif. (USA). Fast Breeder Reactor Dept.). [nd]. Contract EY-76-C-03-0893-013. 25p. Dep. NTIS, PC A02/MF A01.

This paper discusses the use of structural reliability methodology for general systems reliability analyses. It briefly discusses previous applications of this approach to several different types of systems. A description of the basic methodology is given followed by a discussion of the computational processes that are available for arriving at solutions. The basic structural reliability approach involves defining first the "requirements" (or stresses) to which a structure will be subjected in terms of the static and dynamic loadings and other environments, such as temperature, pressure, etc. Secondly, the "capability" (or strength) of the structure to withstand the requirements (stresses) must be defined in terms of the appropriate structural parameters, such as static and dynamic material properties, structural dimensions and configuration, etc. Since, in general, the structural dimensions, configuration, loadings, and other environments are random variables, the capability (strength) and requirements (stresses) are also random variables. Therefore, the reliability of the structure is the probability that the requirements (stresses) imposed upon the structure do not exceed the capability (strength) of the structure to withstand them within a time period of interest. There are, basically, three computational procedures for generating solutions of this type of problem: (1) closed form solution, (2) Monte Carlo simulation, and (3) numerical techniques. The optimal procedure is a combination of these three, depending upon the particular problem.

26436 (HEDL-TI—75002-10) **FSAR amendment 10.** (Hanford Engineering Development Lab., Richland, Wash. (USA)). Sep 1977. Contract EY-76-C-14-2170. 87p. .

Supplementary information is provided on the FFTF Final Safety Analysis Report. (DG)

26437 (NEDO—21480-02) **Boiling Water Reactor feedwater nozzle/sparger interim program report. Supplement No. 2: fracture mechanic analysis of JAERI model pressure vessel test.** Riccardella, P.C.; Delvin, S.A. (General Electric Co., San Jose, Calif. (USA). Boiling Water Reactor Systems Dept.). Nov 1977. 32p. Electricc Co., San Jose, CA.

A fracture mechanics evaluation of the Japan Atomic Energy Research Institute (JAERI) model pressure vessel experiment was

performed using an analytical method which has been used previously to evaluate boiling water reactor feedwater nozzles. Excellent agreement between analysis and experiment was obtained, from which it is concluded that: (1) the test confirms GE predictions of leak-before-break as the hypothetical failure mode; and (2) the fracture mechanics methodology used by GE to predict nozzle crack growth is accurate for the entire range of crack growth, from nucleation to through-wall leakage. These conclusions are particularly significant with regard to very large cracks (greater than 20 percent of nozzle wall thickness) which have never occurred in an operating reactor, but for which the applicability of the method cannot be demonstrated theoretically.

26438 (NEDO—23697) **Preliminary scaled multivent test program plan.** (General Electric Co., San Jose, Calif. (USA). Boiling Water Reactor Systems Dept.). Dec 1977. 26p. Electric Co., San Jose, CA.

This report provides a preliminary description of a program to evaluate multivent chugging effects in Mark II containments with respect to the trend in chugging loads as a function of the number of vents and the confirmation of assumptions used in the multivent hydrodynamic analytical model for calculating pool boundary loads due to chugging. The program is divided into three phases: (1) Scoping Tests and Scaling Relationships—This effort consists of the performance of scoping tests and the development of scaling relationships, to the extent necessary, to establish the specification for the multivent tests. (2) Multivent Testing and Data Analysis—This effort consists of the performance of multivent tests at two scales and data reduction and analysis. (3) Application of Results to Containment Design—This effort consists of defining an application method for Mark II containment boundary assessment through direct analysis of the multivent tests and method verification, and validation of the multivent hydrodynamic model by confirmation of assumptions and model predictions.

26439 (ORNL/NUREG/TM—142) **Breeder Reactor Aerosol Release and Transport Program. Quarterly progress report, April—June 1977.** Fontana, M.H.; Kress, T.S. (Oak Ridge National Lab., Tenn. (USA)). 16 Nov 1977. Contract W-7405-ENG-26. 65p. Dep. NTIS, PC A04/MF A01.

The report summarizes studies designed to investigate radionuclide release and transport from breeder reactors for reactor events of severity up to and including hypothetical core-disruptive accidents (HCDAs). Experimental program topics discussed include (1) CDV-CRI-III design considerations and experimental operation; (2) fuel aerosol characterization studies in the CRI-II facility; (3) NSPP sodium oxide aerosol experiments; (4) FAST facility design, site preparation, and component procurement and fabrication; and (5) exploratory CDV experiments in support of the FAST program. Analytical program topics discussed include an idealized expansion calculational model and a model for UO_2 vapor condensation on cooler structural surfaces.

26440 (ORNL/NUREG/TM—143) **PWR Blowdown Heat Transfer Separate-Effects Program. Thermal-Hydraulic Test Facility experimental data report for test 105.** Clemons, V.D.; White, M.D.; Moore, P.A.; Hedrick, R.A. (Oak Ridge National Lab., Tenn. (USA)). 27 Oct 1977. Contract W-7405-ENG-26. 49p. NTIS, PC E03/MF A01.

Reduced instrument responses are presented for Thermal-Hydraulic Test Facility (THTF) test 105, which is part of the ORNL Pressurized-Water Reactor (PWR) Blowdown Heat Transfer Separate-Effects Program. The objective of the program is to investigate the thermal-hydraulic phenomenon governing the energy transfer and transport processes that occur during a loss-of-coolant accident in a PWR system. Test 105 was conducted to obtain CHF in the THTF in a prescribed flow and power transient. The primary purpose of this report is to make the reduced instrument responses during test 105 available. The responses are presented in graphical form in engineering units and have been analyzed only to the extent necessary to assure reasonableness and consistency.

26441 (ORNL/NUREG/TM—182) **December 1977 monthly highlights for Office of Nuclear Regulatory Research Programs at Oak Ridge National Laboratory.** Mynatt, F.R. (comp.). (Oak Ridge National Lab., Tenn. (USA)). 12 Jan 1978. Contract W-7405-ENG-26. 28p. Dep. NTIS, PC A03/MF A01.

Technical highlights are presented for the following safety-related studies: heavy section steel technology, fission product release from LWR fuel, fission product transport tests, multirod burst tests, Nuclear Safety Information Center, PWR blowdown heat transfer-separate effects, Zircaloy fuel cladding collapse studies, aerosol release and transport from LMFBR fuel, advanced instrumentation for reflood studies (AIRS), HTGR safety analysis and research, design criteria for piping and nozzles, and noise diagnostics for safety assessment. (DG)

26442 (PNL—2417) **Fracture mechanics of thin wall cylindrical pressure vessels: an interim review.** Kurtz, R.J.; Olson, N.J. (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). Aug 1977. Contract EY-76-C-06-1830. 40p. Dep. NTIS, PC A03/MF A01.

The report is a result of activities in the LMFBR Fuel Rod Transient Performance Program sponsored by the LMFBR Branch of the Division of Project Management, U.S. Nuclear Regulatory Commission. One of the objectives is to develop predictions relative to the length, direction, and rate of growth of cladding rips subsequent to (or concurrent with) the initial cladding breach during unprotected transients. To provide a basis for evaluation, Battelle, Pacific Northwest Laboratories has reviewed most available fracture mechanics assessments relative to thin-wall cylindrical pressure vessels. The purpose of the report is to review the various fracture mechanics models and to describe the pertinent fracture parameters. It is intended to provide a formal basis for assessing future analytical predictions of fracture behavior of materials exposed to transient LMFBR thermal and mechanical loading conditions. In addition, the report is expected to provide reference material for evaluating or developing experimental programs required to properly address the problem of predicting fracture behavior of materials during transient events.

26443 (TREE-NUREG—1196) **Response of unirradiated and irradiated PWR fuel rods tested under power-cooling-mismatch conditions.** MacDonald, P.E.; Quapp, W.J.; Mehner, A.S.; Martinson, Z.R.; McCardell, R.K. (SEE CODE- 9502158 EG and G Idaho, Inc., Idaho Falls (USA). Idaho National Engineering Lab.). Jan 1978. Contract EY-76-C-07-1570. 52p. Dep. NTIS, PC A04/MF A01.

The results are presented from the single-rod Power-Cooling-Mismatch (PCM) and Irradiation Effects (IE) tests conducted to date in the Power Burst Facility at the Idaho National Engineering Laboratory. The mechanical, chemical reaction, and thermal response of previously unirradiated and previously irradiated light water reactor type fuel rods tested under power-cooling-mismatch conditions is discussed. A brief description of the test designs is presented. The results of the PCM thermal-hydraulic studies are summarized. Primary emphasis is placed on the behavior of the fuel and cladding during and after stable film boiling.

26444 (UCRL—52314) **Instrumenting a pressure suppression experiment for a MK I boiling water reactor: another measurements engineering challenge.** Shay, W.M.; Brough, W.G.; Miller, T.B. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 14 Jul 1977. Contract W-7405-ENG-48. 135p. Dep. NTIS, PC A07/MF A01.

A scale test facility of a pressure suppression system from a boiling water reactor was instrumented with seven types of transducers to obtain high-accuracy experimental data during a hypothetical loss-of-coolant accident. The instrumentation verified the analysis of the dynamic loading of the pressure suppression system.

26445 (WCAP—9211) **Environmental qualification of safety-related Class 1E process instrumentation.** Ellis, A.E.; Miller, R.B. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA)). Sep 1977. 102p. Electric Corp., Pittsburgh, PA.

This study demonstrates that the resistance temperature detectors (RTDs) used for short-term reactor trip and safety injection and the transmitters used to initiate safety injection for a high steam flow condition will perform their short-term safety functions in the event of an accident. The tests also covered RTDs used for postaccident monitoring and the sensor system used to provide the containment pressure trip and monitoring functions. Both radiation and environmental tests were carried out on instruments identical to those used in Westinghouse PWR operating plants. The results of the test program indicated that the RTDs and transmitters will perform the required functions.

26446 **Computer code for nuclear reactor core thermal transients.** Benedek, S. (Villamosenergiaipari Kutato Intezet, Budapest (Hungary)). *Kernenergie;* **21**: No. 1, 29-34(Jan 1978).

The present paper deals with the analysis of the thermal transients of water-cooled reactor cores. A computational model is presented, in which - besides the initial values - the input data are: flow rate or pressure of the coolant entering and leaving the reactor core, inlet enthalpy as functions of time. The results obtained by the model are: relative heat generation, safety factor against film boiling, temperature of fuel and fuel element cladding as functions of time. Examinations were carried out for a PWR core with fuel elements with walls (assemblies) after failure of the main circulating pumps, blowdown in the primary circuit with flow blockage, and reactivity change.

26447 **Spherical containment system has many advantages.** Godfrey, A.; Madan, A.S.; Loeb, W.A. *Nucl. Eng. Int.;* **22**: No. 265, 44-48(Dec 1977).

The dual spherical containment design adopted for the Cherokee and Perkins nuclear stations is the result of a detailed evaluation of past and present containment concepts. It incorporates many features of the system used in Kraftwerk Union PWR units. The

system is illustrated and the many advantages of the design are described.

26448 TECAR, a new program for LOCA analysis. Carbajo, J.J. (Illinois Univ., Urbana (USA)); Munno, F.J. (Maryland Univ., College Park (USA)). *Nucl. Eng. Des.;* **44**: No. 2, 171-176(Nov 1977).

A new space- and time-dependent containment pressure and temperature analysis code, TECAR, has been developed. The new code is valid for dry containments, has all the features of the present codes used by industry and in addition calculates the temperature in the containment as a function of height (temperature-space dependence). The code has been verified against the experimental data available.

26449 Determination of floor response spectra on the basis of the response spectrum method. Peters, K.A.; Schmitz, D.; Wagner, U. (Internationale Atomreaktorbau G.m.b.H. (INTERATOM), Bensberg/Koeln (Germany, F.R.)). *Nucl. Eng. Des.;* **44**: No. 2, 255-262(Nov 1977).

In this paper a method to determine floor response spectra is proposed which is based on the modal analysis of a support structure with interaction-free, one-degree-of-freedom system attached. The time-consuming methods using real or artificial soil accelerations are avoided as well as some of the arbitrarinesses in the approaches of Biggs or Kapur-Shao.

26450 Nuclear power is not only necessary, but it can also be mastered. EGM talk with Guido Brunner. Koof, A.P. *Ehara Jiho;* No. 11, 8-9(Nov 1977). (In German).

Questions discussed include the following: isn't the energy problem being unnecessarily dramatized; will oil really become as short and expensive as nuclear power promoters tell us; do nuclear power opponents have serious motives; shouldn't clean energy sources like coal, natural gas and solar heat be promoted instead of nuclear power, and does the EC need a community energy policy. Coolly calculated answers to hotly discussed problems, arguments instead of emotions.

26451 How safe is nuclear power. Rasmussen, N.C. *Atom (London);* No. 252, 257-267,283(Oct 1977).

This is an adaptation of a talk by the author delivered to the Thomas Alva Edison Foundation, in the USA. The author headed a study of reactor safety, which has come to be known as WASH-1400. Headings include - why is there a safety question; not a bomb; three layers of safeguards; the safety study methodology; putting the nuclear risk in perspective; stretching the probabilities of nuclear accidents; natural disasters are worse; what are the alternatives; coal versus nuclear; and growth in the use of electricity. Some questions posed and their answers are included.

26452 Nuclear power - a report on progress. England, G. (Central Electricity Generating Board, London (UK)). *Atom (London);* No. 252, 54-256(Oct 1977).

Address by the Chairman of the UK Central Electricity Generating Board on the 24th August 1977. It discussed mainly operational and safety experience, experience in the re-cycling of irradiated fuel, and various research aspects. The impressive record achieved is emphasised, and it is stated that the nation's future nuclear policy should emerge from an informed and soundly based public debate.

26453 Risk assessment in the absence of complete data. Kastenberg, W.E.; McKone, T.E.; Okrent, D. (California Univ., Los Angeles (USA). School of Engineering and Applied Science). *Nucl. Eng. Des.;* **44**: No. 1, 135-146(Oct 1977).

The mathematical basis of risk assessment is examined within the context of frequency-consequence modeling. In particular, its application to technological systems, in the absence of complete data, is discussed. It is found that some systems contain risk-significant singularities (one or two low probability-high consequence events) which greatly influence continuous frequency-consequence distributions.

26454 Equivalent modal response method for seismic design of structures. Gupta, A.K. (IIT Research Inst., Chicago, Ill. (USA)); Chu, S.L. (Sargent and Lundy, Chicago, Ill. (USA)). *Nucl. Eng. Des.;* **44**: No. 1, 87-91(Oct 1977).

A new method is proposed in which the response in several modes of vibration under the three components of earthquake is replaced by the response in a small number of equivalent modes.

26455 Probable simultaneous response by the response spectrum method of analysis. Gupta, A.K. (IIT Research Inst., Chicago, Ill. (USA)); Chu, S.L. (Sargent and Lundy, Chicago, Ill. (USA)). *Nucl. Eng. Des.;* **44**: No. 1, 93-95(Oct 1977).

A new method is proposed by which any response at any location in a structure which is expected to occur simultaneously with a maximum probable response at a given (or reference) location can be calculated.

26456 Reaktorschutzsystem und Ueberwachung von Sicherheitseinrichtungen. (Reactor protection system and supervision of protection equipment). Berlin, Germany, F.R.; Beuth (Oct 1977). 22p. (In German). (DIN—25434).

The rule contains a summary of criteria for the design, reliability requirements, and requirements to be met by the functioning of the reactor protection system. It regulates design, construction, the quality of the equipment, and installing and testing the reactor protection system and its components. The reactor protection system, as a part of the safety system of nuclear facilities comprises all equipment and devices for recording measured values, all equipment and devices concerned with signal processing, the logical part, and the level for controlling the release of protective actions, as well as this equipments' supply with electrical power and auxiliary media. Basic requirements to be met by recording equipment, change limits, electrical power supply equipment, ventilation equipment, and danger alarm systems are to be of the no. 1 category according to this rule.

26457 What will the fast breeder bring us. As an important interlude, nuclear power utilization may be prolonged by fast breeders: but it may also end as a catastrophe. Urban, M. *Sulzer Tech. Rev.;* No. 226, 8(Oct 1977). (In German).

This newspaper article gives a survey of the problems in connection with the fast breeder which are now under public discussion.

26458 Safety no obstacle to a British PWR. Kovan, D. *Nucl. Eng. Int.;* **22**: No. 262, 43-44(Sep 1977).

The main points of the summary report of the Nuclear Installations Inspectorate are highlighted. The conclusions on the following issues are summarised briefly: fault conditions as revealed by the reactor designer, loss of coolant accident, other particular potential fault conditions, integrity of primary circuit, and fuel element behaviour under fault conditions.

26459 Rubber mounts insulate whole reactor from 0.6 g earthquakes. Smith, D. *Nucl. Eng. Int.;* **22**: No. 262, 45-47(Sep 1977).

A description is given of an aseismic foundation bearing developed by Spie-Batignolles for a nuclear station. It also has other potential applications. For the nuclear power plant at Koeberg the bearings are arranged underneath the nuclear island building between an upper and lower raft. They consist of a block of reinforced neoprene elastomer and a set of friction plates of different metals. The neoprene pad acts as a horizontal spring imparting a first mode of translation to the structure of a frequency of about 1 cps depending upon the chosen characteristics of the bearing, the frequency being selected to be outside the range of natural frequencies of the buildings or equipment. The friction plates are designed to have a constant friction value coefficient so that maximum earthquake forces are limited to a low optimised figure. Under an earthquake of 0.15 to 0.20g the structure simply vibrates and returns to its original position. Under more intense conditions the structure vibrates and a certain amount of sliding of the friction plates occurs.

26460 Use of an evaluation device for rod dosimeters in the process computer-aided personnel dosimetry monitoring at the Philippsburg nuclear power station. Friedrich, G. (Kraftwerk Union A.G., Erlangen (Germany, F.R.)); Jansen, G. (Kraftwerk Union A.G., Frankfurt am Main (Germany, F.R.)); Pfeiffer, E. (Frieseke und Hoepfner G.m.b.H., Erlangen (Germany, F.R.)). *Kerntechnik;* **19**: No. 9, 402-408(Sep 1977). (In German).

At the Philippsburg nuclear power station both the access to plant areas and the radiation exposure of persons working in the area of radiation surveillance are monitored by process computer. The personnel radiation dose is measured by means of rod dosimeters. A new device for automatic analyzing rod dosimeter data was developed by Friesseke and Hoepfner in co-operation with Kraftwerk Union. The operation of the AUTORAD, the data transmission to the process computer and the function of the system for personal radiation monitoring are presented.

26461 Personnel monitoring by process computers in nuclear power stations. Friedrich, G.; Grenz, G. (Kraftwerk Union A.G., Erlangen (Germany, F.R.). Abt. Entwicklung, Steuerung, Prozessrechner). *Kerntechnik;* **19**: No. 9, 397-401(Sep 1977). (In German and English).

This paper describes the tasks of personnel dosimetry and access monitoring in nuclear power stations. A system of process computers for the automation of personnel monitoring is designed. Besides the officially evaluated dosimeters (film or TLD) quartz fibre pocket dosimeters are commonly used because of their direct visual readability. The requirements on an automatic dosimeter reading device are discussed. The essential of the new instrument AUTORAD are given.

26462 Neutron dose monitoring using a multiple lithium fluoride TLD badge. Otterberg, J.E. (Omaha Public Power District, Nebr. (USA)); Cipolla, S.J. *Health Phys.;* **33**: No. 3, 256-258(Sep 1977).

The neutron calibration of a combination TLD-600 and TLD-700 LiF badge-type dosimeter used for routine beta, gamma and neutron monitoring of personnel at Fort Calhoun Power Reactor is described. The calibration was done for neutron energies ranging from thermal to about 2 MeV; the range can be expanded through use of the physical model used in the calibration. The neutron sources used were PuF_4, Pu-Be, ^{252}Cf and the Health Physics Research Reactor at ORNL.

26463 Occupational doses in the Ontario Hydro nuclear power program. Wilson, R. (Ontario Hydro, Toronto (Canada)). *Health Phys.;* **33**: No. 3, 177-182(Sep 1977).

The average doses received by Ontario Hydro Nuclear Station workers of various categories have been extracted from the computer based dose record system. Extrapolations of the data have predicted average lifetime doses for the highest exposed categories of workers in the range 43-114 rem. The estimate depends on the data base selected for extrapolation. The total risk factor facing a worker in any industry is comprised of two components; the risk from a chronic ailment and the risk from an accident with immediate effects. The total risk facing radiation workers in the Ontario Hydro nuclear program is compared with the total risk as far as it is known facing workers in some other industries. On this basis, nuclear power station work is comparable to the average risk in North American industry.

26464 Reflections on the assumption of pipe breaks in order to improve safety in nuclear power plants. Geiseler, H. *Tech. Ueberwach.;* **18**: No. 9, 293-295(Sep 1977). (In German).

When assessing safety measures, hypothetical pipe breaks are assumed which require expensive supporting structures in many parts of the plant. These, in turn, require constant supervision in order to guarantee operation according to the rules. Consequent application of the failure hyptothesis requires a way of proceeding in which excessive secondary damage after circumferential and longitudinal cracking in areas relevant for safety are looked for. Knowledge on fracture toughness and on the crack stopping behaviour of pipe materials offers good possibilities for a determination of damage propagation. The reduced fracture surface would result in a reduction of the loads to be supported and of the number of points of support. A major role may also be played by service devices for leak detection. Finally, the safety of the pipe dimensions typical for a given plant may be judged with the aid of leak size determination.

26465 Politics and engineering in nuclear-energy installations. Koenig, H.H. (Brown, Boveri und Cie A.G., Mannheim (Germany, F.R.). Geschaeftsbereich Kraftwerke). *At. Strom;* **23**: No. 5, 105-119(Sep 1977). (In German).

From Reactor congress 1977; Mannheim, Germany, F.R. (29 Mar - 1 Apr 1977).

The author gives a summarising report on the 1977 Reactor Conference where the review lectures gave information on the present social-political and polito-economic questions at issue on nuclear energy, such as the attitude of politicians in the democracy; the effects of zero growth and subdivision; indpendence of energy supply due to a national waste-disposal centre, and adaption of the economy to the changing requirements of the people. By statements on leasing and export finance, the necessity for state promotion and international cooperation in building up a reactor industry, as well as transfer of nuclear technology, he demonstrates the interlinking between political economy and the nuclear industry. He also reports on the state of the work in Germany on studying risks from nuclear power stations having pressure-water reactors; ensuring reliability of output and of the system; the tightening of high-temperature reactor development; the competitive position of nuclear energy, and the energy research programme in the Federal Republic of Germany.

26466 Safety of nuclear power plants. Butz, H.P.; Danzmann, H.J. *CZ-Chem.-Tech.;* **6**: No. 8, 311-316(Aug 1977). (In German).

The peaceful uses of nuclear energy are a firm part of the Federal government's energy programme. Nevertheless, all aspects relevant to the subject, in particular those concerning the national economy and safety, are often discussed controversially. The present article is to contribute to furnishing the interested citizen with basic information on the nuclear energy scene, a subject which demands that personal opinion be expressed. The contribution presents a survey of the extensive field of reactor safety, in the context of which the danger potential, the safety philosophy, the safety framework, the concept of staggered safety, and the risk of nuclear power plants are explained.

26467 Recommendations of the Reactor Safety Commission during its 121st meeting on February 16th, 1977, 300 MWe-THTR prototype nuclear power plant (THTR-300). *Bundesanzeiger;* **29**: No. 124, 3-4(Jul 1977). (In German).

The RSC, under the condition that the emergency measures in case of a disruption of after-heat removal can be realized has no objections against the emergency cooling system being implemented.

26468 Energy from nuclear reactors. Pt. 5. Fast breeder reactor safety. Hospe, J. *VDI (Ver. Dtsch. Ing.) Nachr.;* **31**: No. 28, 10(Jul 1977). (In German).

The author briefly explains the safety technique applied to the fast breeder and compares it with the techniques for other nuclear power plants.

26469 Stress of structures caused by earthquakes according to calculation and measurement. Herzog, M. *Bautechnik;* **54**: No. 6, 196-199(Jun 1977). (In German).

An approximation for assessing statically equivalent substitute earthquake loads instead of the real dynamic mass forces, already earlier communicated (Bautechnik 52(1975), no. 2, pp. 48-61), is improved by introducing an upper limit for the dynamic coefficient (amplification function). Recalculation of two tower-type structures exposed to the ground acceleration caused by an underground nuclear explosion gave an agreement between measurement and calculation sufficient for practical purposes. In this very simple approximation the influence of the higher harmonics of natural vibration remain out of consideration. Nevertheless, its accuracy - above all also with respect to the uncertainty of the initial values - should be sufficient for the majority of practical cases.

26470 Concerning the press report on 'Short circuit in the nuclear reactor' at the Hahn-Meitner Institute in Berlin. *Gut;* No. 2, 1(1977). (In German).

The report is concerned with a transformer which was originally provided for emergency lighting, but was never used, as the emergency lighting equipment was being fed from another source. The transformer was connected to the busbar on the primary side, but the secondary side was not connected. Due to failure of a contractor, the DC from a battery was switched to the transformer. The transformer started to smoulder. The burning of the insulation gave a fire alarm via an ionisation fire detector. The fire was immediately extinguished by a CO_2 extinguisher. According to the operating instructions the reactor was shutdown due to the firm alarm, although there was no real necessity for this.

26471 Extinction of metal fires. Mellottee, H. (Centre National de la Recherche Scientifique, 45 - Orleans-la-Source (France). Centre de Recherches sur la Chimie de Combustion et des Hautes Temperatures). *Rev. Gen. Therm.;* **16**: No. 186, 527-538(1977). (In French).

The main points of a large bibliography on liquid and solid metal fires are set out. The various methods used to fight these fires are presented; covering by powders is specially emphasized. Since this method has promising results, the various possible techniques, extinction by cooling the metal, by blanketing, by formation of a continuous insulating layer (by fusion or pyrolysis of a powder) or by a surface reaction between powder and metal are studied. The conditions of conservation and use of powders are outlined, then the various powders are described: inert powders, powders undergoing a physical transformation (fusion or vitrification of an organic compound, fusion of eutectic inorganic mixtures), multiple effect powders. Precise examples are quoted.

26472 New methodology for the computer-aided construction of fault trees. Salem, S.L.; Apostolakis, G.E.; Okrent, D. (California Univ., Los Angeles (USA). School of Engineering and Applied Science). *Ann. Nucl. Energy;* **4**: No. 9, 417-433(1977).

A methodology for systematically constructing fault trees for general complex systems is developed. A means of modeling component behaviour via decision tables is presented, and a procedure for constructing and editing fault trees, either manually or by computer, is developed. The techniques employed result in a complete fault tree in standard form. In order to demonstrate the methodology, the computer program CAT was developed and is used to construct trees for a nuclear system. By analyzing and comparing these fault trees, several conclusions are reached. First, such an approach can be used to produce fault trees that accurately describe system behaviour. Second, multiple trees can be rapidly produced by defining various TOP events, including system success. Finally, the accuracy and utility of such trees is shown to depend upon the careful development of the decision table models by the analyst, and of the overall system definition itself. Thus the method is seen to be a tool for assisting in the work of fault tree construction rather than a replacement for the careful work of the fault tree analyst.

26473 Auslegung von Kernkraftwerken gegen seismische Einwirkungen. T. 5. Seismische Instrumentierung. (Protection of nuclear power plants against seismic events. Pt. 5. Seismic instrumentation). Koeln, Germany, F.R.; Heymanns (1977). 2p. (In German). (KTA—2201.5).

A seismic instrumentation is described whose principle of measurement is based on the measurement of accelerations, this being in accordance with the state of design practice and equipment technology. An instrumentation differing from the one characterized here may be applied if with its aid it can be detected if the maximum acceleration of the design base earthquake has been exceeded and

thus, by recording the earthquake time behavior, input values for a control calculation can be obtained.

26474 Breakdown transient phenomena at the fall-out of the primary circuit cooling pumps at Paks Nuclear Power Plant. Perneczky, L. (Kozponti Fizikai Kutato Intezet, Budapest (Hungary)). *Energ. Atomtech.;* **30**: No. 2, 72-82(1977). (In Hungarian).

A program of the Central Research Institute for Physics for calculating breakdown transient phenomena at Paks Nuclear Power Plant is presented and the drop-outs of the primary circuit cooling pumps are dealt with in detail. The reactor has been equipped with old pumps with low inertia moments but the use of a new type of main pump with high inertia moment is planned. It was established that the most unfavourable drop-out of this main pump type would not cause heat transmission crisis in any subchannel, the two-phase would be limited to some hot channel and the maximum vapour content would not reach 10 per cent.

26475 Analysis of core disruptive accidents in carbide-fueled LMFBRs. Mync, L.; Bowers, C.H.; Ferguson, D.R. (Argonne National Lab., IL). pp 389-406 of Advanced LMFBR fuels. Leary, J.; Kittle, H. (eds.). La Grange Park, IL; American Nuclear Society (1977).

From International meeting on advanced LMFBR fuels; Tucson, AZ, USA (10 Oct 1977).

See CONF-771008—.

Parametric studies of two hypothetical core disruptive accidents in a large carbide-fueled LMFBR are discussed. The SAS3A code is used to produce speculative scenarios for the unprotected loss-of-flow and transient overpower accident initiators. Aside from the treatment of transient phenomena unique to carbide fuel, the predictions are based mainly on a direct extrapolation from CDA phenomenology developed for oxide fuels. In addition, a comparison is made to the predicted behavior of a similarly-sized oxide-fueled LMFBR to these two accident initiators.

26476 Safety aspects of carbide irradiations in FTR driver positions. Nickerson, G.M.; Bergeron, R.J.; Siegmann, E.R. (Combustion Engineering, Inc., Windsor, CT). pp 407-420 of Advanced LMFBR fuels. Leary, J.; Kittle, H. (eds.). La Grange Park, IL; American Nuclear Society (1977).

From International meeting on advanced LMFBR fuels; Tucson, AZ, USA (10 Oct 1977).

See CONF-771008—.

An assessment has been made of safety implications for irradiation testing of advanced LMFBR carbide fuel in the Fast Test Reactor (FTR). Carbide fuel has been compared with FTR reference oxide fuel; findings indicate that carbide fuel can be irradiated in FTR safely. Investigations were made of two hypothetical core disruptive accident initiating transients: the transient overpower and the transient under cooling sequences. Improved modeling of sodium bond and shroud tube behavior has been developed. Events are changed little by including parametric variations in sodium bond and shroud tube behavior.

26477 Advanced fuels safety comparisons. Grolmes, M.A. (Argonne National Lab., IL). pp 469-480 of Advanced LMFBR fuels. Leary, J.; Kittle, H. (eds.). La Grange Park, IL; American Nuclear Society (1977).

From International meeting on advanced LMFBR fuels; Tucson, AZ, USA (10 Oct 1977).

See CONF-771008—.

The safety considerations of advanced fuels are described relative to the present understanding of the safety of oxide fueled Liquid Metal Fast Breeder Reactors (LMFBR). Safety considerations important for the successful implementation of advanced fueled reactors must early on focus on the accident energetics issues of fuel coolant interactions and recriticality associated with core disruptive accidents. It is in these areas where the thermal physical property differences of the advanced fuel have the greatest significance

26478 Nuclear reactor. Scholz, M. (to Siemens A.G., Berlin (Germany, F.R.); Siemens A.G., Muenchen (Germany, F.R.)). German(FRG) Patent 2,160,991/B/. 30 Dec 1976. 7p. (In German).

An improvement of the accessibility of that part of a nuclear reactor serving for biological shield is proposed. It is intended to provide within the biological shield, distributed around the circumference of the reactor pressure vessel, several shielding chambers filled with shielding material, which are isolated gastight from the outside by means of glass panes with a given bursting strength. It is advantageous that, on the one hand, inspection and maintenance will be possible without great effort and, on the other, a large relief cross section will be at desposal if required.

26479 Reactor building for a nuclear reactor. Haidlen, F. (to Kraftwerk Union A.G., Muelheim an der Ruhr (Germany, F.R.)). German(FRG) Patent 2,513,822/C/. 11 Nov 1976. 7p. (In German).

The invention deals with an improvement of the design of the liner supported by a latticed steel girder structure, which is to guarantee gas-tight insulation of the plant compartments in the reactor building of a PWR. It is provided for the steel girder structure to be covered on its upper surface by grates, which may also suited be entered, and for diaphragms in modular construction to be suspended on the bottom of the girders as a sealing barrier. At the edges they may be sealed by bellows, thus avoiding thermal stresses. The steel girder structure may at the same time serve as support for some parts of the steam pipe.

26480 Nuclear power plant with a heat exchanger serving as steam generator. Kollmar, W. (to Kraftwerk Union A.G., Muelheim an der Ruhr (Germany, F.R.)). German(FRG) Patent 2,362,046/B/. 21 Oct 1976. 3p. (In German).

In a nuclear power plant with a heat exchanger serving as steam generator, whose secondary side is provided with a main-steam pipe and a feedwater pipe, the consequences of a main-steam pipe rupture are to be inhibited. According to the invention, a pipe is connected between main-steam pipe and feedwater inlet which has an isolating device (valve or rupture disc) which will open as soon as the pressure in the main-steam pipe exceeds a given amount.

ENERGY STORAGE

REFER ALSO TO CITATION(S) 26495

MAGNETIC

REFER ALSO TO CITATION(S) 27650, 27651

PUMPED HYDRO

26481 (AD-A—042556) **Marysville Lake hydrothermal study. Report 1. 900-mW project; hydraulic and mathematical model investigation. Technical report, August 1975—October 1976.** Fontane, D.G.; Dortch, M.S.; Tate, C.H. Jr; Loftis, B. (Army Engineer Waterways Experiment Station, Vicksburg, Miss. (USA)). Apr 1977. 86p. (WES-TR—4-77-5). NTIS PC A05/MF A01.

This study was conducted to determine if the proposed Marysville Lake pumped-storage hydropower (900-MW) project could satisfy downstream water temperature objectives. A one-dimensional numerical model was used for simulation and prediction of temperatures within and downstream of Marysville Lake. A physical hydraulic model was used for study and description of the hydrodynamic response of the project to pumped-storage hydropower operations. The physical model, constructed to a distorted scale of 1:1600 horizontally and 1:160 vertically, simulated the dynamic, unsteady-state, density-stratified flows through Marysville Lake and the afterbay or reregulating pool. Information from the physical model was used to modify existing algorithms and to develop new ones for the mathematical model. The mathematical model allowed simulation of the heat exchange characteristics so the thermal regimes within and downstream of the lake could be determined for various hydrologic and meteorologic conditions and various pumped-storage hydropower operations. Results of the study indicate that the project should satisfy the temperature objectives desired downstream.

THERMAL

REFER ALSO TO CITATION(S) 26079, 26080

26482 (AD-A—042234) **Evaluation of eutectic fluoride thermal energy storage unit compatibility. II. Test procedures and post-test evaluation results. Interim technical report, October 1975—June 1976.** Beam, J.E. (Air Force Aero-Propulsion Lab., Wright-Patterson AFB, Ohio (USA)). Mar 1977. 27p. (AFAPL-TR—75-92(Pt.2)). NTIS PC A03/MF A01.

The objective of this work is to develop the required analytical and experimental heat transfer and metallurgical compatibility data necessary to optimize the design and usable life of thermal energy storage systems for surveillance spacecraft VM cryocooler applications. This report will discuss the initial 2000 hours of metallurgical data and the techniques used to obtain this data for various eutectic fluoride thermal energy storage systems.

26483 (SAND—77-8665) **Direct contact heat exchange for latent heat-of-fusion energy storage systems.** Nichols, M.C.; Green, R.M. (Sandia Labs., Livermore, Calif. (USA)). Dec 1977. Contract EY-76-C-04-0789. 28p. (CONF-771203—7). Dep. NTIS, PC A03/MF A01.

From Alternative energy sources symposium; Miami Beach, FL, USA (5 Dec 1977).

Rudimentary computational and experimental results are presented for a thermal energy storage process based on a novel counter-current, direct-contact heat exchange concept, the "shot tower". The process uses a phase change material and a mutually immiscible heat transfer fluid. A two-tank storage system is used, one each for "cool" and "hot" phase change material, respectively. In use, the phase change material is introduced from one of the storage tanks into a unique, direct-contact heat exchanger where it is frozen/melted while it passes through the countercurrently flowing heat transfer fluid which receives/supplies heat from/to the phase change material. Since these external heat exchangers need only be sized to meet the charge/discharge power demand, they can be quite small relative to the size of the storage tanks. The extensive and expensive heat exchanger surfaces required in conventional phase change systems can be totally eliminated. This uniquely simple external heat exchanger serves to make the system considerably less complex and potentially less expensive than any other phase change thermal energy storage system described to date. Preliminary calculations predict that a "shot tower" type heat exchanger using water/paraffin, having a length approximately 2 m (approximately 6 ft) and a dia of approximately 25 cm (approximately 10 in.), could extract heat from a tank of molten paraffin at a rate sufficient to supply domestic hot water to approximately 10 families.

BATTERIES

DESIGN AND DEVELOPMENT

26484 (ANL-K—77-3639-1) **State-of-the-art lead—acid vehicle batteries.** (Gould, Inc., Rolling Meadows, Ill. (USA). Gould Labs.). 26 Aug 1977. Contract W-31-109-ENG-38. 64p. Dep. NTIS, PC A04/MF A01.

This design and cost study reports the state of the art of electric-vehicle batteries, what the technology is capable of mass-producing within two years, and what are the research and development tasks that must be undertaken to achieve goals for both the "improved state-of-the-art" battery and the advanced battery. Energy-intensive and "life-intensive" candidate designs for electric-vehicle lead—acid batteries are discussed, and performance projections are tabulated. 15 figures, 11 tables. (RWR)

26485 (CONF-7606127—1) **Federal battery program for transportation uses.** Landgrebe, A.R.; Klunder, K.; Yao, N.P. (Argonne National Lab., Ill. (USA)). 1976. Contract W-31-109-ENG-38. 15p. Dep. NTIS, PC A02/MF A01.

From 27. power sources conference; Ft. Monmouth, NJ, USA (21 Jun 1976).

Of the battery systems being developed, major efforts are presently or will be concentrated on the following seven systems: advanced lead-acid, nickel-iron, nickel-zinc, zinc-air, iron-air, lithium-metal sulfide and sodium-sulfur batteries. The probability of one or more of these systems meeting the technical requirements for the intended application within the next several years appears good. The ultimate technical/economic feasibility of these systems cannot be fully assessed at this time because many engineering problems must still be resolved. However, the high temperature systems, Li-MS and Na-S systems appear to be good candidates for electric vehicles in a long term.

26486 **Batteries for utility load leveling.** Nelson, P.A.; Yao, N.P. (Argonne National Lab., IL). *Proc. Am. Power Conf.;* **38**: 1381-1390(1976).

Three key areas in the study of batteries for load leveling are addressed: the technical and economic requirements of batteries for applications to electric utilities, the near-term technology for the leads-acid battery and the prospect for its use in utility applications, and the development status and the incentives for developing advanced battery technology. The Battery Energy Storage Test (BEST) Facility, which will be built through a joint Government/industry effort to provide a test bed for advanced batteries in a user environment, i.e., in a utility network, is also described briefly. 1 figure, 6 tables (RWR)

PERFORMANCE AND TESTING

REFER ALSO TO CITATION(S) 26489

26487 (AD-A—042541) **European developments in the Na/S high- temperature battery for automobile propulsion and energy storage.** Sosin, A. (Office of Naval Research (USA). London Branch Office). 13 Jun 1977. 11p. (ONRL-R—5-77). NTIS PC A02/MF A01.

The sodium-sulfur battery is a leading candidate for future use in the propulsion of automobiles, vans, buses, and trains and for energy storage and load-leveling by electrical utilities. This report presents a brief description of the fundamentals of the operation of the battery, with indication of some considerations which control its development into an important technological system. The status of the battery development in England, France and Germany is then reviewed.

MATERIALS, COMPONENTS, AND AUXILIARIES

REFER ALSO TO CITATION(S) 26486, 27020

26488 (AD-A—042182) **Measurement of battery separator resistances in low impedance conductivity cells by ac bridge techniques. Progress report.** Kilroy, W.P.; Moynihan, C.T. (Naval Surface Weapons Center, Silver Spring, Md. (USA)). 26 Apr 1977. 18p. (NSWC/WOL/TR—77-47). NTIS PC A02/MF A01.

Measurement of the resistance of battery separator membranes is frequently accomplished by taking the difference between the resistances of an electrolyte-filled conductivity cell with and without the separator inserted between the electrodes. For low-resistance separators this may involve measurements of impedances of a few tenths of an ohm. It is shown via equivalent circuit analysis and experimental data on a low-impedance cell filled with 45% aqueous KOH solution that ac bridge measurements of separator resistances can be seriously in error if proper account is not taken of electrode impedance.

26489 (DOE/EA—0001) **Environmental assessment: Battery Energy Storage Test (BEST) Facility, Hillsborough, Somerset County, New Jersey.** (Department of Energy, Washington, D.C. (USA). Div. of Electric Energy Systems). Dec 1977. Contract EY-76-C-02-2857. 30p. Dep. NTIS, MF A01.

Portions of document are illegible.

The probable impact on the environment which may result from the construction and operation of a National Battery Energy Storage Test (BEST) Facility adjacent to Sunnymeade Road Substation of Public Service Electric and Gas Company in Hillsborough Township, Somerset County, New Jersey, is described. Particular features of facility design that will be included to minimize the environmental impact during operation are also discussed and evaluated. It is concluded that construction and initial operation of the BEST Facility will not have a potentially significant impact on the quality of the human environment. The proposed facility design and construction methods incorporate features to protect the environment under normal conditions and credible accidents. The Facility conforms to local zoning plans and is expected to enhance the local environment when completed. This activity does not constitute a major federal action. The greatest environmental impact is expected to occur during site preparation and construction of the Facility. This assessment is confined to the environmental impact of construction and initial test operations using lead—acid batteries only at this facility and excludes a detailed evaluation of the potential environmental effects of the total battery development program. 7 figures. (RWR)

26490 (RLO/2434—1) **Research on alkaline zinc secondary electrodes with emphasis on life improvement. Annual progress report, June 15, 1976—March 15, 1977.** Hamby, D.C. (Linfield Coll., McMinnville, Oreg. (USA). Research Inst.). 28 Mar 1977. Contract EY-76-S-06-2434. 92p. Dep. NTIS, PC A05/MF A01.

Overpotential measurements were made on Air Force Aero Propulsion Laboratory (AFAPL) zinc secondary electrodes operating in cells with limited convection. Average anodic overpotential increases with number of cycles, and is much larger than the cathodic overpotential. In order to keep the anodic overpotential below a preset value, e.g., 200 mV, the half-cycle duration must be shortened as cycling continues. Vacuum refilling of the cell does not restore the capacity of the zinc electrode to its initial value. The overpotential of the zinc electrode varies from site to site over the electrode surface, and certain areas of the electrode exhibit consistently higher overpotentials than other areas over the lifetime of cell operation. Active material distribution as ZnO over used test electrode surfaces reinforces conclusions from previous results that the rate of lateral shape change is significantly reduced by limiting convective flow parallel to the apparent electrode surface. No correlations could be made between Zn or ZnO distributions over the used electrode surfaces and overpotential measurements. Such correlations might become apparent when difficulties in obtaining Zn metal distributions characteristic of the electrode surfaces immediately after termination of cycling are solved. Comparisons of overpotential behavior of these zinc electrodes with behavior predicted on the basis of an x direction model developed by Bennion, Newman and Sunu indicate qualitative agreement of anodic behavior; however, the observed cathodic behavior differs from that predicted by the model. Significant physical differences exist between the model and these electrodes; therefore, one cannot ask for quantitative comparison, but the difference between observed and predicted cathodic behavior may indicate the need for model revision. 36 figures, 10 tables.

26491 **Electrode assembly for bipolar battery.** Fritts, D.H. US Patent 4,022,952. 10 May 1977. Filed date 19 Dec 1975. 4p.

A bipolar electrode is described which has, between active materials, a heat sink fabricated from a porous electrical and heat conductive material, such as sintered silver. Impregnating the porous material with a phase-change heat absorbent material having a high heat of fusion, such as beeswax, provides an electrode having a very large thermal capacity for a high discharge current density battery.

26492 **Controlling the filling of alkaline batteries.** Kirkonos, V.A. *Elektr. Teplovoz. Tyaga;* No. 1, 27-28(Jan 1976). (In Russian).

The apparatus in use on a locomotive is designed for topping up batteries with electrolyte; it consists of a vessel above the battery, a rubber hose, a feeler-clamp, and a connecting lead. The feeler end is fed into an aperture in the element. If the electrolyte level is right, the contacts are bathed in it and impinge on the signalling block. If no buzzer is heard, the level on the feeler is pressed manually and the water from the vessel pours in; the electrolyte is thus raised to the right level as recorded on the control panel.

26493 **Protection of lead accumulators against low discharge.** Remmers, G. *Elektriker;* **15**: No. 2, 47-48(1976). (In German).

The author describes a battery control device Type DE-TR produced by the firm of Varta which is used for protecting lead accumulators from low discharge. An electronic circuit measures the rectified voltage during operational discharge which is mostly intermittant, gives a signal when the discharge voltage of the battery remains under the permitted lowest limit and blocks the power consumption. This device is used as battery protection device in industrial trucks but may also be used for other purposes. The device can also be used for operation with impulse control.

APPLICATIONS

REFER ALSO TO CITATION(S) 26522, 26579, 26580, 26581, 26582

ENERGY MANAGEMENT AND POLICY

ENERGY ANALYSIS AND MODELING

REFER ALSO TO CITATION(S) 26497, 26498

26494 (EMD—77-57) **Net energy analysis: little progress and many problems.** (General Accounting Office, Washington, D.C. (USA)). 10 Aug 1977. 14p. Accounting Office, Washington, DC.

The Federal Nonnuclear Energy Research and Development Act of 1974 requires ERDA to analyze and consider potential net-energy production in planning and carrying out its RD and D programs. Although ERDA has supported a number of studies involving net-energy analyses, it has made only minimal use of the results. It is recognized that net-energy analysis is a relatively new concept and involves major state-of-the-art and other problems. Because of these problems, some of the studies have shown widely different net-energy yields for a given technology. These widely varying results tend to discredit net-energy analysis and may impede its further development into a useful tool for energy planning and priority setting. Already, considerable controversy exists among energy policy and decision makers in Government, industry, and academia concerning the potential usefulness of the net-energy concept. The GAO recommends that ERDA develop a formal, comprehensive management plan, including objectives, milestones, and target dates for timely resolution of the problems associated with net-energy analysis; develop procedures for implementing the plan and decision points for evaluating progress; aggressively implement the plan and annually report to the Congress on the status and results of these efforts; and develop plans and procedures to use net-energy analysis to the extent practical in planning and carrying-out energy RD and D. (MCW)

26495 (UCRL—50029-77) **Energy and Resource Planning Group FY 1977 annual report.** Ramsey, W.J. (ed.). (California Univ., Livermore (USA). Lawrence Livermore Lab.). 27 Oct 1977. Contract W-7405-ENG-48. 31p. Dep. NTIS, PC A03/MF A01.

The Energy and Resource Planning Group continued its activities in assessing and planning long-range research and development. The LLL Energy Model (LLLEM), which improves assessment capability, has several significant advantages: more efficient and easier to use, capable of modeling regulated or otherwise constrained markets, and is nonproprietary. Several studies to supply improved input to the model are included: completing an update of the world oil situation; building a world oil model; studying effects of institutional constraints on the potential development of shale oil; following the evolving national energy plan (taxes, coal conversion, etc.); and making a compatibility study of the Strategic Environmental Assessment System (SEAS) with the LLLEM. The Group devoted a major effort to transportation planning and analysis; system analysis, conceptual design studies, and planning support to the Transportation Energy Conservation Division of DOE. Also, a multilaboratory study of energy-storage power systems for automobiles was directed for DOE and results published. The results show while some of the energy-storage power vehicles can provide performance comparable to that of conventional internal combustion engine vehicles, they would be heavier and more expensive. The value of regenerative braking for vehicles in recovering kinetic energy was assessed. Such braking would have the most benefit in vehicles already equipped with energy storage systems and whose driving cycle involves many stops and starts. A conceptual design study on a possible "transition" electric vehicle was completed. Such a vehicle would be battery/flywheel powered, with a small ICE for range extension. The Group supported DOE-SAN on an ad hoc basis in preparing a western regional briefing document to DOE-HQ in a variety of ways and to the California Energy Resources Conservation and Development Commission in assessing tidal power for California.

ECONOMICS AND SOCIOLOGY

REFER ALSO TO CITATION(S) 25985, 26510

26496 (BNWL-RAP—16) **Management of social and economic impacts associated with the construction of large-scale projects: experiences from the Western coal development communities.** Greene, M.R.; Curry, M.G. (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). Jun 1977. Contract EY-76-C-06-1830. 55p. Dep. NTIS, PC A04/MF A01.

The construction and operation of large-scale energy or resource development projects are accompanied by environmental, social, and economic changes or impacts. Impact assessment is the key tool used to determine which impact areas will most severely affect the community and will thus need to be managed. Impact management, only recently recognized as part of the assessment process, includes public and private actions to ameliorate impacts. The use of available impact management strategies can affect the outcome or change in the social and economic environment in a community. Therefore, an inventory of available strategies and the capabilities of local governments to use such strategies should be an integral part of any social and economic impact assessment. This provides a link between impact assessment and management. This report provides an introductory analysis to some of the more complex issues raised by social and economic impact management, with experiences cited from Western coal-development communities. Following an introduction, the paper is divided into sections corresponding to the major social and economic impacts experienced by rural communities surrounding an energy development. Each section contains a brief introductory description of the types of problems typically associated with the impact sector, and a discussion of management strategies either proposed or implemented for the impact. The management strategies are presented in tabular form, indicating the level of government responsible for implementation. 10 tables, 72 references. (MCW)

26497 (EPRI-EA—592) **ETA-MACRO: a model of energy-economy interactions.** Manne, A.S. (Stanford Univ., Calif. (USA). Dept. of Operations Research). Dec 1977. 82p. Dep. NTIS, PC A05/MF A01.

ETA-MACRO simulates a market economy through a dynamic nonlinear optimization process. To describe the production relationships within this economy, two dynamic submodels are incorporated: (a) ETA, a process analysis for energy technology assessment; and (b) a macroeconomic growth model providing for substitution between capital, labor, and energy inputs. A variety of energy-sector policies may be explored in this way, but here the focus is on one specific policy option—banning the introduction of additional civilian nuclear power plants in the U.S. Under base-case assumptions, it turns out that a "no nuclear" policy would have negligible macroeconomic effects prior to the year 2000, but that it could lead to an annual loss of the order of $100 billions by the year 2010. Other numerical assumptions will of course lead to very different conclusions.

26498 (EPRI-EA—593) **Methodology for predicting the demand for new electricity-using goods. Final report.** (Charles River Associates, Inc., Cambridge, Mass. (USA)). Dec 1977. 81p. Dep. NTIS, PC A05/MF A01.

Consumers frequently are faced with a choice of which of a variety of similar goods to purchase. When new goods are being introduced or the characteristics of existing goods are changing, conventional demand functions do not adequately handle the analysis. This study exposits a model (along with an algorithm for its estimation) to analyze such cases. The potential and requirements for

applying this model to the market for home-temperature-conditioning alternatives are considered to predict the future demand for heat pumps with specified characteristics. The concept (though not the execution) of the model is simple: to model adequately the market for a group of similar goods one must allow for the possibility of variation in personal tastes. To accomplish this the weights of the various characteristics in the utility function are assumed to be drawn from parametrically specified distributions. The estimation procedure consists of finding the maximum likelihood value of these parameters. After the model and an estimation technique for it are developed, a small artificial example is used to illustrate its forecasting properties. These properties are discussed in terms of their desirability and their relation to the basic properties of the model. Also, for a new-good scenario, a comparison is made with the logit model. The applicability of the model to studying the demand for heat pumps is discussed, and the specifics of such a study are illustrated. The results and a discussion of a previous application of the model to the demand for new automobiles are then presented. A final chapter points out connections to other literature and some areas with potential for further research.

26499 Cost of energy over the next decade. White, N.A. *Energy World;* No. 42, 1-9(Nov 1977).

The principal determinants of energy costs from now until the late 1980s are discussed. Factors discussed include level and pattern of world energy consumption; conventional energy reserves and costs; new energy sources; security of energy supplies; and intervention policies by producing governments and energy-consuming governments. It is concluded that the cost of all forms of energy over the period considered will be largely dictated by the pricing policies of the Organization of Petroleum Exporting Countries. The factors affecting the future behavior of OPEC are analyzed and discussed. An examination of the UK scene within a European framework is included.

26500 Impact on the employment situation of the construction and operation of power plants. Bald, M. *Atomwirtsch., Atomtech.;* **22**: No. 10, 518-519(Oct 1977). (In German).

The Deutsches Institut fuer Wirtschaftsforschung (German Institute for Industrial Research) has assessed the impact on the labor situation arising from the construction of nuclear power plants and hard-coal-fired power plants, respectively, in two studies. The approach used involved a breakdown of production into various branches of industry and a conclusion, from production through labor productivity in the respective branch, to the manpower requirement corresponding to the respective productions.

26501 Energy shortage and price increases: effects on world economy and standard of living. Juergensen, H. (Hamburg Univ. (Germany, F.R.). Inst. fuer Europaeische Wirtschaftspolitik). *Sprechsaal;* **109**: No. 11, 657-662(1976). (In German).

The author deals with the world economy situation, which changed in particular as a consequence of the new price level that developed in connection with the oil crisis. The demand of the oil countries for a petroleum price index tied to the prices for important import goods led to total profits of the oil-exporting countries and resulted in an increasing capital export into the industrial countries. Interconnections of the new economic situation in the world are discussed. (2 tables, 21 refs.)

26502 Energy Resources Conservation and Development Commission 1978/79 budget. Sacramento, CA; Energy Resouces Conservation and Development Commission (1976). 213p. (NP—22822).

The Energy Resources Conservation and Development Commission presents its 1978/79 budget for review. The proposed budget reflections are summarized. Budget Change Proposals, Introduction to Program Budget Package, and Revenue Information comprise the first three sections. The last section, Commission Budget Summaries contains information on Commission and Administration Program, Power Plant Siting Program overview, Energy Resources Conservation Program overview, and New Resources and Technologies Program overview (solar element, geothermal element, fuels element, and energy systems integration element). (MCW)

ENVIRONMENT, HEALTH, AND SAFETY

REFER ALSO TO CITATION(S) 26192, 26193, 26512, 26893, 26932

ENERGY RESOURCES

REFER ALSO TO CITATION(S) 26496, 26513

26503 Western States energy resource development update 1976. Wilkinson, L.E. Lakewood, CO; Western Interstate Nuclear Board (1976). 87p. (NP—22644). .

The Western Interstate Nuclear Board was chartered to foster interstate (12 states) cooperation in resolving nuclear and other energy-related problems through various research, planning, and informational efforts. Energy demands in the West (1950 to 2000); energy production in the West (1970 to 1985); and energy resources under development, 1976 to 1985 (oil, natural gas, hydroelectric, coal, uranium, and geothermal), are considered. Factors impacting on consumption (conservation and economics) and factors impacting on production are summarized. The final two sections consider contingency planning and conservation efforts in member states and actions open to member states. (MCW)

RESEARCH AND DEVELOPMENT

REFER ALSO TO CITATION(S) 26495, 26521

26504 (LA—6807-PR) **Energy technology. Progress report, January—March 1977.** Kirk, W.L. (comp.). (Los Alamos Scientific Lab., N.Mex. (USA)). May 1977. Contract W-7405-ENG-36. 86p. Dep. NTIS, PC A05/MF A01.

A separate abstract was prepared for each of the five main sections.

26505 (LA—6807-PR, pp 49-59) **Energy systems and statistics.** Lohrding, R.K.; Waller, R.A. May 1977.

In Energy technology. Progress report, January—March 1977.

Brief summaries are included for 17 programs funded by various ERDA divisions and non-ERDA organizations. The only summaries containing information of significance are the following: (A) under the Regional Studies Programs: (1) National Coal Utilization Assessment, and (2) Air Quality and Rocky Mountain Energy Development; (B) Computer Graphics, Statistics, and Economics; (C) U. S. Water Resources Council—identifying and assessing water resource implications inherent in Federal fuel supply and energy demand projections; and (D) Energy Flow Diagrams—completion of computer graphics code (FLOMAP) that generates on film energy flow diagrams for all states of the U. S. Eleven titles of articles published (or to be published) from the various programs are listed. Also, ten oral presentations from staff members presented at conferences during the quarter are listed.

NUCLEAR ENERGY

REFER ALSO TO CITATION(S) 25915, 25926, 25935, 26202, 26294, 26295, 26332, 26413, 26497

26506 Conserving uranium without the fast breeder. Davies, J. *Nature (London);* **270**: No. 5636, 376-377(1 Dec 1977).

The theme of this paper is that the fast breeder reactor, with its alleged problems, is not the only way forward for the nuclear power program. Some alternative schemes are here discussed, and in particular the use of proton accelerators to produce the intense source of neutrons required for breeding, a scheme that hitherto has not been widely discussed, but is considered to be practical, economically viable, and safe. At several laboratories high-intensity accelerators are replacing fission reactors as research instruments providing high-intensity neutrons. These neutron fluxes can effect fertile-to-fissile conversion and so produce far more energy than they consume. Once breeding has been established in the Th-U cycle the tremendous reserves of Th, not U, are the ultimate constraint, and it may be that this cycle plus the use of accelerators is the nuclear industry's best chance. The design of some high-intensity proton accelerators for the purpose is mentioned.

26507 Nuclear fuel in the fuel and energy complex. Ermakov, G.V. *Teploenergetika (Moscow);* No. 5, 2-6(May 1977). (In Russian).

The role of nuclear fuel in the fuel and energy complex is pointed out. Utilization of nuclear energy will make it possible to relieve the strained situation in the energy balance and establish a higher production and technological potential of the electric power industry.

TRANSPORT AND STORAGE

REFER ALSO TO CITATION(S) 26495, 26522, 26580

WASTE HEAT UTILIZATION

26508 District heating as a task for government and economy. Existing networks to be extended systematically: special responsibil-

ities for communities. Ziegler, A. (Bundesministerium fuer Forschung und Technologie, Bonn (Germany, F.R.)). *Beratende Ing.;* No. 7/8, 16-18, 20-21(1976). (In German).

The article makes general reflections on energy conservation by the expansion of regional district-heating grids and estimates the probable energy demand for space heating. Power stations may be more efficiently utilized by using them as heating power stations in power-heat coupling and by feeding the waste heat into district heating networks. The conception of a Federal district heating grid is presented. The necessary integration of district heating into urban development and regional planning is pointed out. 6 figs., 3 refs.

CONSERVATION

REFER ALSO TO CITATION(S) 26551, 26556, 26706

26509 (HCP/M1223—1) **Recommendations for enforcing and administering lighting-efficiency standards in existing public buildings in New York State. Final report.** (Resource Planning Associates, Inc., Washington, D.C. (USA)). Dec 1977. Contract EY-76-C-03-1223. 81p. Dep. NTIS, PC A05/MF A01.

The Energy Policy and Conservation Act established a grant program under which the Federal Energy Administration would formulate guidelines and procedures for states to receive the financial and technical assistance needed to develop and implement energy-conservation plans. To qualify for funding, a state must demonstrate that its plan will result in savings of 5% of projected 1980 energy consumption by 1980. At a minimum, each state plan must contain five specific conservation measures. One of those measures is the implementation of lighting-efficiency standards in public buildings. To assist the state of New York in its efforts to determine the most-efficient, cost-effective means of enforcing lighting standards in existing public buildings, Resource Planning Associates, Inc. investigated various enforcement procedures; conclusions, supported by the methodology and data, are provided in this report. (MCW)

26510 Energy conservation retrofit process for existing public and institutional facilities. Washington, DC; Public Technology, Incorporated (1977). 114p. (NP—22812).

The purpose of the manual is to provide assistance to public officials first considering energy conservation in existing public buildings. The manual focuses on management decisions which must be made in implementing energy conservation programs for existing buildings. It provides assistance in developing a plan of attack, establishing schedules, selecting buildings, creating preliminary energy savings estimates, developing engineering work statements, evaluating consultants, estimating fees, and rough estimating of construction costs. The building energy retrofit process described here is divided into four distinct work phases: review of current energy consumption and selection of the most promising facilities for retrofit; detailed engineering and architectural study of potential energy conservation modifications for selected facilities (prioritization of options in terms of energy savings and payback); implementation of desirable retrofit changes; and monitoring of energy savings achieved and aggressive follow-up maintenance programs. The final section describes some examples of successful retrofit.

SUPPLY, DEMAND, AND FORECASTING

REFER ALSO TO CITATION(S) 25719, 25720, 25721, 26502, 26514, 26525, 26527, 26868

26511 (AD-A—042456) **Fort Knox regional energy survey. Final report.** Beaudry, R. Jr; Singh, T. (Nottingham (H.D.) and Associates, Inc., McLean, Va. (USA)). Jan 1977. Contract DAAK70-76-C-0275. 92p. NTIS PC A05/MF A01.

Impact of energy consumption at Fort Knox on the regional energy supply was assessed. Consumption of natural gas at the installation was significant with the post using 1.25% of the total natural gas consumption within the State of Kentucky and 3.45% of the total natural gas sales of its supplier (Louisville Gas and Electric Co.). Supply of other sources of energy in the region such as fuel oil, propane, coal and electricity is not impacted significantly by the Post. Fort Knox's bill for all energy sources for FY 76 was $5.1 million. To meet future energy demands of the Post, several recommendations have been made in the form of an energy plan; however, further studies are required to establish the feasibility of some of the alternatives outlined. (Author)

26512 (NP—23054) **Northwest Energy Policy Project. Energy supply and environmental impacts: conventional energy sources. Study Module III-A final report.** McFadden, J. (Energy, Inc., Idaho Falls, Idaho (USA)). 1977. 345p. NTIS.

Four forms of energy for Oregon, Idaho, and Washington are discussed: natural gas, petroleum, coal, and electrical energy. Supply sources for these forms of energy from the 1965 to 1974 period are discussed in Chapters II-V, with energy cost and price data included. In addition to considering historical supply, possible supply sources for the four forms from 1980 to 2000 are identified. Factors that will determine the amount and price of the energy forms are discussed. Environmental and social impacts of natural gas, petroleum, coal, hydroelectric, and light water reactor systems are discussed in Chapter VI. The three scenarios considered can be described as applying to conditions of moderate, low, and high rates of growth in energy demand and supply. In Chapter VII, assumptions for these scenarios, along with price and supply forecasts for each of the conventional energy forms, are presented. The major in-state environmental impacts are summarized in this chapter for each scenario as well as the total impacts of the regional energy system. The final chapter deals with specific issues of energy supply in the Northwest. Included in this chapter are sections on (1) consumptive versus instream water uses, (2) imports of coal versus power from Montana and Wyoming, and (3) the social impacts of power plant construction. (MCW)

26513 Alternatives to LNG in the United States. Hunsaker, B. (El Paso LNG Co., Houston, TX). pp 36p, Session I, Paper 6 of Fifth international conference on liquefied natural gas. Volume I. Chicago; Institute of Gas Technology (1977).

From 5. international conference on liquefied natural gas; Dusseldorf, F.R. Germany (29 Aug 1977).

See CONF-770879—P1.

The United States is primarily dependent upon oil and natural gas, total energy demand continues to grow, and the domestic supply of those fuels cannot satisfy existing requirements. There is little likelihood of increasing the domestic supply of oil and natural gas to the extent required, and it is essential that natural gas service be maintained and that the level of reliance on oil imports be reduced. The use of other available domestic resources and new technologies does not appear to provide suitable, sufficient or timely relief, and most would increase water requirements. Increased consumption of coal may compromise environmental standards; utilization as a feedstock to produce synthetic fuels has been delayed; and if used to generate electricity as a substitute for other fuels, delivered equivalent energy would be very costly and necessitate equipment conversion. Nuclear plant construction has been delayed, and breeder reactor and fusion technology development is not expected soon. Geothermal potential appears limited and presents both operational and environmental difficulties, oil shale development is not assured, and solar energy appears extremely capital intensive and unlikely to make a significant contribution for many years. Therefore, none of these alternatives appear to be quite as satisfactory as LNG imports from the standpoint of price, time, volume or environmental quality.

POLICY, LEGISLATION, AND REGULATION

REFER ALSO TO CITATION(S) 26051, 26520

26514 (CONF-770149—) **Energy: now and in the future.** (Netherlands Energy Research Centre, Utrecht). 1977. 115p. Dep. NTIS (US Sales Only), PC A06/MF A01.

From Conference of the Netherlands National Energy Research Steering Group; Utrecht, Netherlands (27 Jan 1977).

The above title was the theme of the conference, chaired by W. van Gool. The introductory speech, The National Energy Research Programme: Points of Departure, was given by F.H.P. Trip. Seven additional papers were: Analysis of the Energy Problem: Summary of the Principal Aspects of the LSEO Reports, W. van Gool; Coal Research and Development, E.L. Mackor; Energy Conservation, D.G.H. Latzko; Combined Cycles, L.H.T. Rietjens; On the Development of Energy Extraction from Nuclear Fusion, J. Kistemaker; ZWO and Energy Related Research, R. van Lieshout; and Energy Research: Priorities, Financing and Management, R.F.M. Lubbers.

26515 (EMD—77-16) **National energy policy: an agenda for analysis.** (General Accounting Office, Washington, D.C. (USA)). 27 Jan 1977. 60p. Accounting Office, Washington, DC.

Report to the Congress by the Comptroller General of the United States.

Today the United States relies far more heavily on imported energy than it did at the time of the embargo. Yet, the Nation still lacks a focal point for dealing with energy problems and a coherent set of energy policies. In this report GAO identifies eight critical national energy issues it believes require the attention of the Congress and the public in the years ahead. The issues analyzed and dealt with in detail are: how the Federal government can encourage energy conservation; resolving the problems of nuclear fission so it can become a major energy source; the extent of relying on fossil

fuels (especially coal) to fulfill future energy demand; the effect of Federal subsidies, taxes, and regulations on energy supply and demand; improving the Executive Branch energy organization and decisionmaking processes; prospects for transition to essentially renewable energy resources (geothermal, solar, fusion); energy resources on public lands being wisely managed by the Federal government; and compatibility of domestic and international energy policies and do they reflect international economic and political realities. (MCW)

26516 (TID—28130) **Interactions among the National Energy Plan and the President's Environmental Message: the Coal Conversion Regulatory Program.** Levine, M.D.; Craig, P.P.; Fullen, R.E.; Wharton, J.C. (Stanford Research Inst., Menlo Park, Calif. (USA)). 23 Jun 1977. Contract W-7405-ENG-48. 37p. TIC.

The NEP calls for significant expansion of the use of coal—by 400 million tons per year by 1985—under the proposed coal conversion regulatory program. About half of that expansion is expected without the Plan; the other half will require measures called for in the Plan. To permit this much expansion and to protect environmental quality, three conditions will have to be met: Best available control technology (BACT) will be required for all new facilities; existing facilities must install equipment to meet current limits on emissions; and all pollution control equipment will have to be operated and maintained properly. A failure to meet any one condition will lead to a deterioration in environmental quality. Regional variations are extremely important. States in the Southwest and far West will be affected more than the average by increased emissions and in the South and Southwest by the cost of the coal conversion program, which may be a real burden on the affected industries, and will occur largely in this region.

26517 **Towards a more conservative energy policy.** Forman, N. London; Conservation Political Centre (1977). 80p.

The subject is treated under the following headings: the meaning of energy policy; previous attempts to formulate United Kingdom energy policy; patterns of energy supply and demand (in the UK) (current and future); towards a more conservative energy policy (the use of energy in the various sectors, the conversion and distribution of energy (coal, nuclear power, electricity, oil and gas, renewable sources)); energy policy in broader perspective (international context, cost benefit assessments, contrasting patterns of energy use, ethical issues).

26518 **Staatliche Foerderung 'umweltfreundlicher' Technologien. (Governmental promotion of technologies not harmful to the environment).** Kapp, K.W. Goettingen, Germany, F.R.; Schwartz (1976). 208p. (In German).

In the introduction, the author goes into detail as far as the significance of alternative energy technologies are concerned, as they are an integral part of environmental policies. It is pointed out that the promotion of new technologies is also social policy. The second part contains a review of existing models and practical starting points for alternative technologies. In the third part, a general review is given on the organisation and structure of the present research system in industrialized societies with market economies, particularly in the Federal Republic of Germany. The 4th part deals with today's governmental promotion of technologies not harmful to the environment and with their inadequateness. In the 5th part the most important problems of promoting and introducing technologies not harmful to the environment are discussed systematically, particularly the discussion of target formulations and priorities which turn up during the process of decision-making conducted by governmental, scientific and research policies. 3 fegs., 6 tables, 172 refs.

FOSSIL FUELS

REFER ALSO TO CITATION(S) 25722

COAL

REFER ALSO TO CITATION(S) 25625, 25661, 25719, 25720, 25721, 26496, 26516

26519 (EMD—77-59) **First Federal attempt to demonstrate a synthetic fossil energy technology: a failure.** (General Accounting Office, Washington, D.C. (USA)). 17 Aug 1977. 23p. Accounting Office, Washington, DC.

Report of the Comptroller General of the United States.

ERDA's first attempt at demonstrating a synthetic fossil-energy technology by converting coal to a clean-burning liquid fuel has been a failure. Thus, the objectives of the Clean Boiler Fuel Demonstration Program to demonstrate by 1983 that coal can be successfully converted to clean-boiler liquid fuel cannot be achieved because it takes 8 to 12 years from project conception through successful demonstration. In our view the project failed because: Research and development had not been sufficiently carried out to resolve several significant technical problems; ERDA never had both an adequate work plan for the project and an effective system to monitor and control the contractor's progress and project costs; and ERDA did not take timely action to redirect or terminate the project when it became evident that it was in serious trouble. A good management system of planning, oversight, and control would have enabled ERDA to identify project problems in a timely manner and to minimize cost overruns and schedule slippages. Without such a system, anything but project failure was highly unlikely in light of the significant technological problems of the Coalcon process.

PETROLEUM

REFER ALSO TO CITATION(S) 25801, 25802, 25806, 25814

26520 **Divestiture: the pros and cons.** Murray, F.X. (ed.). Washington, DC; Georgetown University (1976). 73p. (NP—22653). .

This is the third in a series of Seminar Reports being issued by the Center for Strategic and International Studies, Georgetown University. Four panelists discussed divestiture. Opposing divestiture were a scholar and an oil company executive. Supporting the divestiture proposition were an economist and an attorney. While touching on the economic question of consumer benefits or penalties arising from divestiture, the discussion did not center there. The arguments ranged from the practical problems of transition to speculation on the world of 1985 and beyond. Included at times were factors as diverse as OPEC, corporate liabilities, employment, and offshore leasing policy. On one issue, the panelists did agree: divestiture is an important issue that will have considerable impact on our energy future, and therefore must be addressed and resolved one way or the other. Furthermore, it should be resolved expeditiously to minimize uncertainty for all involved. Panelists were Donald Henriksen, Atlantic Richfield Comany; Martin Lobel, partner, Lobel, Norris, and Lamont; Frederic Scherer, Federal Trade Commission; and S. Fred Singer, University of Virginia. (MCW)

NATURAL GAS

REFER ALSO TO CITATION(S) 25802, 25845, 25848, 25850, 25851, 25856, 25857, 25862

HYDROGEN AND SYNTHETIC FUELS

REFER ALSO TO CITATION(S) 25625

ELECTRIC POWER

REFER ALSO TO CITATION(S) 25977, 26498

26521 (EPRI-RD—3) **Digest of current research in the electric utility industry.** (Electric Power Research Inst., Palo Alto, Calif. (USA)). 1977. 626p. Dep. NTIS, PC A25/MF A01.

The Electric Power Research Institute (EPRI) began operations in 1973 for the purpose of expanding electric energy Research and Development under the voluntary sponsorship of the nation's utility industry—public, private, and cooperative. Its goal is to develop a broad, coordinated, advanced technology program for improving electric power production, transmission, distribution, and utilization in an environmentally acceptable manner. EPRI developed the Research and Development Information System (RDIS) in 1974. RDIS is a computerized data base of research projects sponsored by EPRI and by individual electric utilities throughout the United States. The heart of RDIS is a computerized on-line data base containing approximately 3000 records on R and D projects. New projects, changes reflecting progress, changes in research objectives, and updated funding information are entered as supplied by the utilities, thus keeping the data base current. The data base is organized into thirteen major subject categories: General R and D Support, Hydroelectric Power, Nuclear Power, Fossil Fuels, Advanced Power Systems, Transmission, Distribution, Stations and Substations, Consumer Utilization, Economics, Personnel, Area Development, and Environmental Assessment.

26522 (HCP/T2857—1) **Economic assessment of the utilization of lead-acid batteries in electric utility systems. Final report.** Johnson, A.C.; Hynds, J.A.; Nevius, D.R.; Nunan, G.A.; Sweetman, N. (Public Service Electric and Gas Co., Newark, N.J. (USA)). Nov 1977. Contract EX-76-C-02-2857. 203p. Dep. NTIS, PC A10/MF A01.

The purpose of this study is to search for and identify specific applications in which lead-acid batteries might be economically competitive on an electric utility system. Particular attention is given to searching the PSE and G system for installations of batteries

which could defer or cancel costly transmission and/or distribution projects. Although the transmission and distribution data are based on specific applications on the PSE and G system, the generation data are based on a national reference system. This system was developed in RP-729-1 "Economic Assessment of the Utilization of Fuel Cells in Electric Utility Systems" which was prepared by PSE and G for the Electric Power Research Institute. Data on lead-acid battery costs and characteristics were provided by ERDA. The report analyzes and summarizes all costs and savings attributable to lead-acid batteries. The general approach used is to first identify specific applications for the PSE and G transmission and distribution system. The amounts and required characteristics of lead-acid batteries to satisfy the needs of the transmission applications are determined.

26523 (NP—22952) **Statistics of publicly owned electric utilities in the United States.** (Federal Power Commission, Washington, D.C. (USA)). 1975. 198p. TIC.

The publication presents financial and operating information about publicly owned electric utilities in the U.S., utilities with operating revenues of $1 million or more. Included are data on 25 municipal wholesalers, 374 retailers, and 76 Federal projects.

26524 (ORO/5468—1) **Regional power systems planning: a state of the art assessment. Interim report, survey of planning models.** Haden, C.R. (Oklahoma Univ., Norman (USA)). Jan 1978. Contract EC-77-S-05-5468. 310p. Dep. NTIS, PC A14/MF A01.

This report covers Task A in the Department of Energy's research project, "Regional Power Systems Planning: A State of the Art Assessment." Tasks include: (A) Electric Utility Planning Models; (B) Generation Planning; (C) Transmission Planning; (D) Electric Utility Component of Supply/Demand Models; and (E) Systems and Processes. In addition to its utilization in the project, it is hoped that this survey document will be of use to the industry for reference purposes. The survey was not intended to be comprehensive in that it did not reach all companies and institutions using planning models. It was designed to reach a representative group of institutions which would hopefully find all the major planning models in use. This report contains the responses to the survey, a list of institutions surveyed, and a list of those responding, with the pages where their responses appear. It also includes an index of model names, with the pages where they appear. It is realized that much of this index is redundant and that model names vary from company to company, masking the redundancy. However, the list still provides substantial aid to the reader in locating particular types of models by function or by author. The remainder of the project is on schedule and a draft final report should be available during June 1978.

26525 (RAND-P—6006) **Real-time individual rationing as a response to an electricity shortage.** McKay, D. (RAND Corp., Santa Monica, Calif. (USA)). Sep 1977. 5p. Corp., Santa Monica, CA $1.50.

The characteristics of an electricity shortage are examined. Electricity supply has no natural queuing procedures when instantaneous excess demand exists. This then implies that some method of rationing must be developed. The most drastic is a system-wide blackout. The more accepted approach involves selective load shedding (local blackout) and voltage reduction (brownout). Assuming that the shortages being considered are some distance in the future, rationing mechanisms that will take some time to implement may be considered. Mechanisms proposed here take advantage of new metering and load control devices made possible by microelectronics. Remote control of specific items is selective and the consumer may respond to rationing in any way he likes as long as his total demand does not exceed the instantaneous rating of his main circuit breaker. If each consumer has a microprocessor-based metering/load control instrument, then complex arrangements are possible at little incremental cost. (MCW)

26526 **Growth and adaptation processes in the power industry of the Federal Republic of Germany. A simulation model.** Winje, D. Meisenheim/Glan, Germany, F.R.; Hain (1977). 275p. (In German).

Following the analysis of the process hitherto used, a planning instrument in the form of a system-analytical model of the power industry of the Federal Republic of Germany is presented in this study. Starting from the demand of final energy, the available quantity required of primary energy and the possibilities of availability under alternative conditions are investigated. A simulation model is set up based on the System-Dynamics formulation developed by Jay W. Forrester. This formulation was originally conceived as basis of undertaking strategies for long-term management decisions. The present model is written in the Dynamo programming language and has been implemented at the Technical University Berlin on the IBM 370/158.

26527 **Supplement to "Technical Documentation of Staff Procedures for Estimating Peak Demand".** Logan, R. Sacramento, CA; Energy Resources Conservation and Development Commission (1976). 11p. (NP—23056).

This supplement contains various statistical results and input assumptions used in the staff peak demand forecast (NP—21849; see EAPA 3:4236). The staff has also made a part of the record of EA-76-1 computer printouts of all the programs used in the peak demand model, which are available for public inspection.

ELECTRIC POWER GENERATION

REFER ALSO TO CITATION(S) 26189, 26193, 26500

CONSUMPTION AND UTILIZATION

REFER ALSO TO CITATION(S) 26193, 26505

26528 (NP—23033) **International energy trends: 3rd quarter 1977 and recent trends.** (Organization for Economic Co-Operation and Development, 75 - Paris (France)). 6 Feb 1978. 48p. Dep. NTIS (US Sales Only), PC A03/MF A01.

For the first three quarters of 1977 energy consumption in OECD countries was 2.7 percent higher than for the same period in 1976. During the same period industrial production rose by 4.5 percent and gross domestic product by 4.0 percent. In Japan, energy growth was 3.6 percent and GDP, 6.5 percent. In the OECD area, coal consumption rose by 1.2 percent and oil consumption by 3.7 percent. In the United States as in 1976, oil consumption grew more quickly than total energy demand (9 percent oil, 4.5 percent energy). In Europe (EEC) modest growth of total energy requirements (+0.6 percent) reflected low growth of GDP (+2.0 percent). Industrial energy demand was particularly weak (total heavy fuel oil -7 percent, total coal -3.0 percent). Reductions occurred in oil consumption (-2.6 percent against +6.5 percent in 1976) and in coal consumption (-3 percent against +7.4 percent). Electricity demand grew 2 percent and natural gas consumption rose 1.6 percent. In Japan oil consumption increased 6.7 percent and gas consumption 19.3 percent. Using tentative fourth quarter data, it is estimated growth rate for 1977 OECD energy consumption will be 1.7 percent; USA, 3.0 percent, Japan, 2.0 percent; and Europe, 0.2 percent. (MCW)

26529 (NP—23050) **Energy use in the dairy industry (report No. 25).** Vickers, V.T.; Shannon, D.V. (New Zealand Energy Research and Development Committee, Auckland). Jul 1977. 56p. Dep. NTIS (US Sales Only), PC A04/MF A01.

Questionnaires on energy use were sent to all dairy plants in New Zealand. Data are provided for 1974 to 1975 and extrapolated to a 1977 level due to considerable changes in the cost, availability, and utilization. Energy use and conservation are now of considerable importance. Following an introductory chapter, the New Zealand dairy industry, its products, manufacturing costs, market organization, and expected changes and possible energy savings are discussed. Subsequent information on heating equipment and boiler-house fuel economy, efficient utilization of heat in dairy processing, and electrical energy and its utilization is provided. (MCW)

26530 **Energy use in agriculture: now and for the future.** Ames, IA; Iowa State University (1977). 31p. (NP—23062).

Agriculture production now uses 3 percent of the energy consumed in the USA, as a result of producing food for its 220 million and, additionally, millions of people around the world. Three great benefits are derived from this input of energy into agriculture: greater quantities are produced, food prices for consumers are low, and all consumers benefit from agricultural exports. The report covers the following subjects: energy use in agriculture; energy sources; crop production, harvesting, and drying; animal agriculture; and energy supply and farming. (MCW)

UNCONVENTIONAL SOURCES AND POWER GENERATION

SOLAR

REFER ALSO TO CITATION(S) 25985, 26030, 26044, 26048, 26051

OTHER

26531 (HCP/L50172—01) **Overcoming institutional barriers to solid waste utilization as an energy source. Final report.** (Gordian Associates, Inc., New York (USA)). Nov 1977. Contract EM-75-C-01-8403. 284p. Dep. NTIS, PC A13/MF A01.

This study investigated the factors, especially the institutional barriers, that affect the demand for the various forms of energy available in municipal solid waste (MSW)—processed fuel, low-quality pyrolysis gas, and steam. Since all of the products can be converted into electricity, emphasis was placed on possible barriers

to participation by investor-owned utilities. The study included evaluation of process technology (excepting pyrolysis oil), product characteristics, marketability, price, environmental impacts, and such institutional issues as regulatory constraints and utility attitudes toward risk-sharing in projects to recovery energy from waste. The resulting investigation showed that at the end of 1976, except for one demonstration project, no investor-owned electric, gas, or steam utility was purchasing any energy product derived from MSW. The exception was the Union Electric Co. of St. Louis which has been cofiring refuse-derived solid fuel (RDSF) with coal since 1972 under a recently completed USEPA demonstration project. Although Union Electric has expressed its intention to undertake a much larger project, using an unregulated subsidiary to process the waste, this approach seems unlikely to become a model for the industry. Financial and operating risks in MSW-energy recovery are unattractive. Contributing causes include inflation, the lag in rate relief, high interest rates, lack of sufficient investment capital, reliance on fuel adjustment clauses, and the likelihood that MSW-energy investment costs will not be allowed in a utility rate base. Technologies for recovering energy from waste are developing rapidly. However, under any current technology, the cost to recover energy remains greater than the price the recovered energy can command in the marketplace.

26532 (HCP/L50172—02) **Overcoming institutional barriers to solid waste utilization as an energy source. Executive summary.** (Gordian Associates, Inc., New York (USA)). Nov 1977. Contract EM-75-C-01-8403. 25p. Dep. NTIS, PC A02/MF A01.

This is the executive summary for the report (same title as above) HCP/L50172—01, which was abstracted separately.

ENERGY CONVERSION

MHD GENERATORS

26533 (JPRS—69811) **Translations on USSR science and technology. Physical Sciences and Technology No. 18.** 19 Sep 1977. Translation of USSR articles. 52p. NTIS.

Separate abstracts were prepared for two of the ten papers presented. The remaining eight papers were not within the scope of ERA. (WHK)

DESIGN AND DEVELOPMENT

26534 Complex study on a base-load MHD power station of open cycle. Levental', G.B.; Monastyrskaya, A.R.; Khokhlov, L.K. (AN SSSR, Moscow. Inst. Vysokikh Temperatur; Moskovskij Ehnergeticheskij Inst. (USSR)). *Teploenergetika (Moscow);* No. 1, 5-9(Jan 1976). (In Russian).

An attempt is made of an element-wise study of the technological scheme for the basic magneto-hydro-dynamic power station (MHDPS) with an open cycle, combined with the complex technical and economic analysis of connections between elements and with the determination of synthesizing indices of the economy with respect to the scheme as a whole. Such an analysis allows to establish the many-dimensional technical and economic interaction of parameters which helps to find the optimal values of two parameters for certain values of specific design expenses and one of MHDPS parameters (the oxigen concentration in the oxidant, the heating temperature of the oxidant or the electric conductivity of plasma beyond the channel of MHD generator). It follows from the relation that when the investment in MHDPS is decreased, regardless of the type of equipment responsible for this decrease, the zones of the oxigen concentrations and the temperature level of the oxidant heating decrease. It shows that the perspective of the application of the oxigen enrichment for the basic MHDPS ia should be be associated with the increase of capital investment. The generalizing forms of dependence obtained between the scheme parameters (as well as the regions of their numerical values) can serve as a reliable foundation for the subsequent improvements during the design of the equipment and MHDPS as a whole and conducting the optimization research with the help of its detailed mathematical model.

PERFORMANCE AND TESTING

REFER ALSO TO CITATION(S) 26150

26535 Special characteristics of the aerodynamic organization of the working process in a conical-type combustion chamber for a magnetohydrodynamic unit. Dvoinnishnikov, V.A.; Laryushkin, M.A. (Moscow Power Institute). *High Temp. (USSR) (Engl. Transl.);* **15**: No. 3, 522-526(Nov 1977).

This article gives the results of investigations of the organization of the working processes in the conical combustion chamber of an MHD unit. The mechanism of the interaction between the flows in the chamber and the effect of the boundary conditions on it are brought out. The laws governing mixing and the effect of the geometry of the chamber on the outlet characteristics are established. A method is proposed for calculation of the aerodynamics in the chamber. The results of the investigations can be used for the adjustment and design of combustion chambers of similar type.

26536 Limiting values of the energy generated by pulsed MHD converters. Popel', O.S.; Sinkevich, O.A. (High-Temperature Institute, Academy of Sciences of the USSR). *High Temp. (USSR) (Engl. Transl.);* **15**: No. 2, 320-324(Sep 1977).

The energy characteristics of a pulsed magnetohydrodynamic energy converter are invesitgated in a wide range of magnetic Reynolds numbers. The connection of the converter both to an ohmic and inductive load is examined. The conditions of the optimal matching of the converter with the ohmic and inductive loads which provide the maximum level of withdrawal of energy from the flow are obtained. The criterion determining the operating regime of the converter (inductive storage, active external load) most advantageous from the standpoint of maximum energy removal is obtained. The limiting values of the generated energy is analyzed.

26537 Two-dimensional electrical effects in a frame-type MHD channel. Bityurin, V.A.; Burakhanov, B.M.; Zhelnin, V.A.; Kovbasyuk, V.I.; Kuznetsova, T.N.; Medin, S.A. (High-Temperature Institute, Academy of Sciences of the USSR). *High Temp. (USSR) (Engl. Transl.);* **15**: No. 2, 324-332(Sep 1977).

The characteristics of frame-type magnetohydrodynamic (MHD) channels in the presence of non-uniform distributions of the electrical conductivity and rates of flow in the channel cross section are investigated. A method is developed for solving the electrodynamic problem numerically in parametric form; this facilitates analysis of the electrical characteristics of the channel, once having obtained the solution of a certain elliptic equation. The influence of the plasma parameters on the integrated characteristics of the frame-type channel is considered, and the latter are compared with the characteristics of a Faraday channel. An analysis of experimental data obtained in the "R" frame-type channel of the U-25 Installation is presented.

MATERIALS, COMPONENTS, AND AUXILIARIES

26538 (FE—2246-3(Rev.A)) **Testing and evaluation of MHD materials and substructures. Quarterly technical progress report, January—March 1977.** (Mississippi State Univ., Mississippi State (USA). Energy Research Center). Oct 1977. Contract EX-76-C-01-2246. 56p. Dep. NTIS, PC A04/MF A01.

The objective of this work is to simulate the slag-seed-gas conditions that will exist at various substructures of the coal-fired baseline MHD power plant and evaluate the performance of the substructures. The initial tests will attempt to characterize as closely as possible the ambient conditions that will exist in the radiant boiler of the baseline MHD plant. Information will be obtained on the chemistry of the gas stream and slag deposits at selected points representing radiant boiler locations and the regenerative air heater inlet. A primary objective of this phase of the contract is to provide preliminary engineering data to assist in the design of engineering tests of subscale prototype air heaters and of slag/seed recovery systems. The tests will also provide information for materials selection for the radiant boiler. The scope of work consists of the following tasks: Task I. Testing and Evaluation of Metallic Components Under Static Conditions. Task II. Testing and Evaluation of Metallic Components Under Dynamic Conditions. Task III. Technical Support for the National MHD Program. Progress is reported on each of the tasks.

26539 (JPRS—69811, pp 28-38) **SPMS-1 superconducting magnet system for an MHD generator.** Zenkevich, V.B.; Kir'yenin, I.A.; Tovma, V.A. 19 Sep 1977. Translation of Technical report No. A 77/2, Institute of High Temperatures, Academy of Sciences USSR, Moscow, 1977, 16 pp.

In Translations on USSR science and technology. Physical Sciences and Technology No. 18.

Progress in developing an effectively operating MHD power plant depends to a great extent on advances in the development of superconducting magnet systems (SPMS) for MHD generators. In research and development work at the Institute of High Temperatures of the Academy of Sciences USSR a superconducting magnet system (the SPMS-1) for MHD generators has been designed, built and tested; this unit produces a magnetic field of up to 4 T in a "hot" space 300 mm in diameter and 1000 mm long (within this space the nonhomogeneity of the magnetic field is no more than +-5 percent). A description of the magnet and cryostat is given.

DUCT ENGINEERING AND FLUID DYNAMICS

REFER ALSO TO CITATION(S) 26538

EHD GENERATORS

26540 (AD-A—046120) **Electrofluid dynamic generators and cycle performances for optimally matched injectors. Final technical report Sep 74—Jul 76.** Lawson, M.O. (Air Force Aero-Propulsion Lab., Wright-Patterson AFB, Ohio (USA)). Jul 1976. 29p. (AFAPL-TR—76-111). NTIS PC A03/MF A01.

The Air Force in-house analytical portion of the electrofluid dynamics (EFD) direct energy conversion research is described. The experimental portion has been given in the final report, AFAPL-TR-76-35. EFD generator performance analyses have been extended to apply to more general injector-generator types and to include effects of friction and mixing losses. Through the definition of an EFD specific work function, a convenient method of optimally matching an injector to a specific generator is described. Application examples are presented for high overall efficiency cycles as well as for low capitol cost generators.

DESIGN AND DEVELOPMENT

REFER ALSO TO CITATION(S) 25956

THERMIONIC CONVERTERS

REFER ALSO TO CITATION(S) 26533

PERFORMANCE AND TESTING

REFER ALSO TO CITATION(S) 26150

26541 **Volt-ampere characteristics of thermionic converters in the diffusion regime with Coulomb collisions.** Gus'kov, Yu.K.; Zherebtsov, V.A. *Zh. Tekh. Fiz.;* **46**: No. 2, 292-296(Feb 1976). (In Russian).

Specific features are considered of TEC operation under diffusion conditions for high cathode temperatures (2000-2300 deg K) when Coulomb collisions are important. It has been shown that in the absence of magnetic field Coulomb collision exercise no influence on density current. When the magnetic field is present, Coulomb collisions increase the ratio of density current to density current in the absence of magnetic field; this effect, however, is smaller, than the one resulting from electron-atom collisions. Coulomb collisions effect on the current-voltage characteristic and the generated power is studied.

FUEL CELLS

DESIGN AND DEVELOPMENT

26542 (ANL—77-79) **Advanced fuel cell development. Progress report, July—September 1977.** Ackerman, J.P.; Kinoshita, K.; Sim, J.W.; Swaroop, R.; Nelson, P.A. (Argonne National Lab., Ill. (USA)). Nov 1977. Contract W-31-109-ENG-38. 27p. Dep. NTIS, PC A03/MF A01.

This report describes advanced fuel cell research and development activities at Argonne National Laboratory (ANL) during the period July-September 1977. This work has been aimed at understanding and improving the performance of fuel cells having molten alkali-carbonate mixtures as electrolytes; the fuel cells operate at temperatures near 923°K. The largest part of this effort has been directed toward development of methods for fabricating and evaluating electrolyte structures for these cells and optimizing their design. Cell performance, life, and cost are the criteria of optimization. During this period, the low-temperature synthesis of rodlike β-$LiAlO_2$ for the electrolyte tile has been accomplished using inexpensive ($0.16/kg or $0.073/lb) alumina as the starting material, thereby reducing the alumina cost by a factor of twenty-seven. The intent of cell testing is to evaluate components under operating conditions that are as typical of the state of the art as possible. The present cells (7-cm-dia, cylindrical) have Type 316 stainless steel housings and current collectors, nickel anodes, and nickel oxide cathodes. During this quarter, a clear relationship has been established between electrolyte structure and cell performance, and the effectiveness of a wet-seal protection technique has been demonstrated for more than 2600 h. A satisfactory method for testing of electrolyte specimens for thermal expansion and high-temperature static creep has been developed. Results for the first few samples are given, and a tentative preliminary correlation with conventional creep behavior is proposed.

26543 (EPRI-EM—576) **Advanced technology fuel cell program. Interim report.** King, J.M. Jr. (United Technologies Corp., South Windsor, Conn. (USA). Power Systems Div.). Nov 1977. 78p. Dep. NTIS, PC A05/MF A01.

Molten carbonate fuel cells, advanced phosphoric acid fuel cells, advanced fuel processors and the use of coal and coal products in central stations or dispersed fuel cell powerplants are under investigation. Molten carbonate fuel cell activities focused on reactant containment, increased endurance, and improved performance. At the beginning of the report period a 19-cell stack of 1 square foot cells had successfully demonstrated scale up and thermal management. This test was terminated after 1400 hours because of significant reactant leakage. At the end of the report period, short term tests of subscale cells incorporating improved electrolyte tiles demonstrated operation without reactant leakage at similar conditions. Improved cells incorporating sufficient electrolyte storage to achieve 40,000 hours of maintenance free operation demonstrated performance equal to that of earlier cells without this capability. Satisfactory anode stability was demonstrated over 13,000 hours of continuous operation on endurance cells. A subscale cell demonstrated initial power density 25 percent greater than that demonstrated previously. The effort is continuing to demonstrate cell performance and function for extended periods at the cell stack level. An advanced phosphoric acid cell concept, with potential for reduced cost and reduced resistance losses, was demonstrated in a 20-cell stack. The best performing cells achieved expectations, and the concept was successfully demonstrated. Investigations showed that adiabatic steam reforming holds promise for processing No. 2 fuel oil in dispersed fuel cell generators, and subscale testing was conducted to establish acceptable operating conditions. A laboratory scale rig operated stably on No. 2 fuel oil for 1000 hours with a methane conversion of 95 percent. The effort is presently focused on reducing the amount of oxygen required, improving methane conversion, and scale-up.

MATERIALS, COMPONENTS, AND AUXILIARIES

REFER ALSO TO CITATION(S) 26542

ENERGY CONSERVATION, CONSUMPTION, AND UTILIZATION

BUILDINGS

26544 **Principles of nuclear district heating.** Melent'ev, L.A. (Inst. of High Temperatures, Moscow). *Therm. Eng. (USSR) (Engl. Transl.);* **23**: No. 11, 1-4(Nov 1977).

Translated from Teploenergetika; 23: No. 11, 6-9(Nov 1976).

Optimal use of nuclear fuel in the future fuel and power balance of the USSR is possible only when it is extensively used not only for power supply but also for heat supply, for which the majority of natural gas and fuel oil is used at present. Nuclear district heating makes provisions for supply of process steam and hot water. The principles of district heating based on fossil fuel and of district heating based on nuclear fuel are different. This is due to the low fuel component of electric power and heat at the nuclear station and the direct dependence of cost of the station on unit capacity of the reactor. From the mentioned properties of the NPS it follows that the mixed condensing-and-district heating type of NPS is most efficient, especially when the existing types of reactors are used for district heating. There may be instances when the electrical unit capacity of a nuclear station has to be limited. In that case relatively less efficient specialized nuclear h. and p. stations should be constructed. It is very important to select types of district heating turbines for both types of NPS and to start designing and manufacturing them; to develop optimal cycle arrangements for process steam and hot water supply from NPS, including the selection of optimal coefficient of district heating and parameters of steam and hot water supplied.

26545 **Problems of improving the methods of designing heat supply systems.** Savin, V.I.; Khrilev, L.S.; Sokolova, V.Yu.; Il'kevich, Z.A.; Novikova, L.P. *Therm. Eng. (USSR) (Engl. Transl.);* **23**: No. 11, 5-14(Nov 1977).

Translated from Teploenergetika; 23: No. 11, 9-17(Nov 1976).

A condition providing for the possibility of deviation of actual values of initial data from their design values should be assumed as a basis of development of the methods of designing centralized heat supply systems and district heating systems, first of all at the stage of development of heat supply schemes. Therefore, in designing heat supply systems the main initial information should be assigned not in determined form but in the form of a range of contingent variations established for each initial quantity as a result of careful analysis of exising experience and local conditions with allowance for which particular designing is conducted. In optimization of the development of heat supply systems of large towns and industrial units it is advisable to examine a 15 year-long design period with subdivision of it into three stages: 5, 10, and 15 years. To

eliminate one of the existing inconsistencies between static methods of designing heat supply systems and the continuity of development of these systems it is necessary to change to "sliding" designing the employment of which will make possible better connection between schemes under development with the continuously developing heat supply systems.

26546 Some means of increasing efficiency of district heating in the tenth five-year period. Shitsman, S.E. *Therm. Eng. (USSR) (Engl. Transl.);* **23**: No. 11, 15-17(Nov 1977).

Translated from Teploenergetika; 23: No. 11, 18-20(Nov 1976).

With considerable lagging of the development of h. and p. (heat and power) stations behind the growth of heat load of large towns with concentrated heat load, determination of the optimal value of the projected coefficient of district heating of h. and p. stations under construction should be based on the most efficient use of the planned district heating capacity on the scale of the whole country and not of individual h. and p. stations. Decrease in the coefficient of district heating from 0.5 to 0.6 to 0.35 to 0.4 ensures increase in connected heat load by a factor of 1.5, and increase in power generation while meeting demands for heat by 20 percent, and fuel economy for the introduction of district heating capacity planned for the five-year period of about 7 million tons. The same fuel economy can be attained with increase in peak-load capacity of the existing h. and p. stations and with decrease in the coefficient of district heating.

26547 Hydraulic design of a branched heating network, employing an electronic digital computer. Zinger, N.M.; Andreeva, K.S.; Fedorov, E.M.; Oshchepkova, T.B. (Siberian Power Inst., Novosibirsk, USSR). *Therm. Eng. (USSR) (Engl. Transl.);* **23**: No. 11, 18-21(Nov 1977).

Translated from Teploenergetika; 23: No. 11, 20-24(Nov 1976).

Hydraulic design of a branched heating network, required in order to plot the piezometric graph, to determine pressures and available heads in the network and in users' units, to determine diameters of the nozzles of the elevator pumps and plate restrictions in users' units, is a very laborious task because the number of sections and of users in the networks of large towns amounts to hundreds. Since the network is continually developing (loads increase, diameters of pipes over some sections change, new sections of network are constructed, etc) the hydraulic design of the network is periodically updated. VTI and the Siberian Power Institute (SEI) developed an algorithm and a program of hydraulic design for a branched heating network on an M-222 digital computer. The problem of hydraulic design of a branched heating network is formulated.

26548 Main means of improving designs of heating networks. Skvortsov, A.A. *Therm. Eng. (USSR) (Engl. Transl.);* **23**: No. 11, 22-24(Nov 1977).

Translated from Teploenergetika; 23: No. 11, 24-27(Nov 1976).

The rate of development of district heating in the USSR in the past five-year period has considerably increased. Owing to engineering imperfection of some elements, the heating networks do not ensure sufficient reliability of centralized heat supply. Increasing the reliability is therefore one of the main and basic requirements with respect to improving heating networks and their individual structural elements. The main reason for the vulnerability to damage of heating networks is corrosion of the outside surface of pipes due to periodical moistening of the thermal isulation when there are no sufficiently effective protective anticorrosive linings. Another significant defect associated with wetting of insulation is the increase in heat losses from pipes due to increase in the coefficient of heat transfer of the insulation, and in a number of instances owing to its rapid mechanical disintegration. Based on the results of scientific research in design and construction, a discussion is given of various methods of improving heating network design.

26549 Principles of arrangements of heating networks in towns, their automation, and remote control. Gromov, N.K. *Therm. Eng. (USSR) (Engl. Transl.);* **23**: No. 11, 26-38(Nov 1977).

Translated from Teploenergetika; 23: No. 11, 28-38(Nov 1976).

The present-day level and prospects for development of centralized heat supply systems in Soviet towns make it absolutely necessary thoroughly to examine the demands made on their operation and principles of their arrangement. The composition of users has radically changed: the vast majority of houses are equipped with hot water supply systems and the majority of public buildings are equipped with systems of plenum ventilation. Many users (hospitals, boarding schools, hot houses, etc.) permit no interruptions in heat supply. One of the main elements of a heat supply system is the heating network which should transport heat energy and distribute it to heating substations of the users. The function of distribution of the heat carrier (hot water) predetermines the inclusion of the distributive heating substations into the concept "heating network". The demands which should be met by the heating network serving domestic and municipal users of the town are examined, and recommendations for meeting the town network requirements are given.

26550 Matrix rotor fan combines heat recovery with balanced ventilation. Field, A.A. *Refrig. Air Cond.;* **80**: No. 955, 48, 50(Oct 1977).

The use of the matrix rotor fan for packaged air conditioning units to provide in-built heat recovery for both cooling and heating cycles is suggested. By using a foamed plastic cylinder as a rotor, it is possible to combine centrifugal fan action with regenerative heat transfer, the rotor acting both as impeller and heat transfer matrix.

26551 Regulations establishing energy conservation standards for new nonresidential buildings. Sacramento, CA; Energy Resources Conservation and Development Commission (1977). 61p. (NP—22642).

Regulations related to energy conservation standards for new non-residential buildings in California are presented. These regulations apply to standards for the design of the building and its systems for heating, cooling, and lighting. Thermal insulation requirements and control system requirements are included. (LCL)

26552 Instructions for treating internal coatings of man-sized pipes and containers. Vater, W. *Goldschmidt Informiert;* **3**: No. 38, 42-46(Nov 1976). (In German).

The steel, iron, or concrete carrier is dealt with, technical equipment and measuring instruments such as ventilation, air conduction, heating, filters, dew point mirrors, thermometers and anemometers are described. After this, details of the coating such as materials, mixture, viscosity, processing equipment are gone into as well as, in the testing of the finished coating, adhesion, layer thickness, pores and form.

RESIDENTIAL BUILDINGS

REFER ALSO TO CITATION(S) 26498

OFFICE BUILDINGS

REFER ALSO TO CITATION(S) 26509, 26510

SCHOOL, MUNICIPAL AND OTHER PUBLIC BUILDINGS

26553 (AD-A—042641) **Energy control system study for Fort Belvoir, Virginia. Final report.** Demetroulis, N.M. (NMD and Associates, Alexandria, Va. (USA)). 25 Jul 1977. Contract DAAG53-76-C-0171. 18p. NTIS PC A02/MF A01.

A computerized analysis of the feasibility and cost of providing a central energy control system at Ft. Belvoir, Virginia is presented. Results include listing of buildings, initial installation costs, payback determinations, energy savings, dollar savings and maintenance and operating cost estimates. The methods and logic of the study may serve as a guide for similar analyses for other military facilities. (Author)

COMMERCIAL AND INDUSTRIAL BUILDINGS

REFER ALSO TO CITATION(S) 26509, 26510

TRANSPORTATION

REFER ALSO TO CITATION(S) 26495

LAND AND ROADWAY

REFER ALSO TO CITATION(S) 26498, 26706

26554 (AD-A—046008) **Pavement recycling using a heavy bulldozer mounted pulverizer. Special report.** Eaton, R.A.; Garfield, D.A. (Cold Regions Research and Engineering Lab., Hanover, N.H. (USA)). Sep 1977. 30p. (CRREL-SR—77-30). NTIS PC A03/MF A01.

Recycling of paving materials is gaining acceptance as a means of savings in pavement reconstruction or rehabilitation. The need to conserve natural resources and increasing costs of select virgin materials have made recycling pavements economically attractive. Pavements that currently have low serviceability indices due to surface irregularities such as cracks, bumps, spalling, potholes, etc., may be broken up to meet specified granular base course gradation requirements and reused as a base for the new surface. CRREL developed a permafrost excavating attachment for heavy bulldozers and a prototype test rig was constructed. Tests were conducted on frozen soils, gravels, and ledge. In September 1976, this rig was used to pulverize a flexible street pavement in Hanover, N.H., and highway pavement test sections at a CRREL test facility.

The resultant processed material met Corps of Engineers base course gradation requirements. The machine can process 120 square ft of pavement structure per minute to a depth of 12 inches. The most uniformly graded material was obtained at a drum speed of 15 revolutions per minute. Once the pavement is broken down from the solid mass (asphalt concrete pavement), the machine does not further break down or pulverize the aggregate. A minor amount of dust was evident during the operations.

INDUSTRY AND AGRICULTURE

REFER ALSO TO CITATION(S) 26529, 26530

26555 (BMFT-FB-T—77-01) **Scenarios chemical technology.** Schaude, G.R.; Legler, H.; Schuster-Wolff, A. (Battelle-Institut e.V., Frankfurt am Main (Germany, F.R.); Dornier-System G.m.b.H., Friedrichshafen (Germany, F.R.); Fraunhofer-Gesellschaft zur Foerderung der Angewandten Forschung e.V., Karlsruhe (Germany, F.R.). Inst. fuer Systemtechnik und Innovationsforschung). Jun 1977. 264p. (In German). Dep. NTIS (US Sales Only), PC A12/MF A01.

The scenario technique was used as a planning tool for the preparation of the special research program. Five different scenarios were written with different sets of assumptions in order to outline the alternative situations of the West German chemical industry in the year 2000 and their effect on the raw materials supply. By using the scenario technique it was possible to take into consideration the important surrounding areas, i.e., raw materials markets, trends in the economy, energy supply and environment, to integrate existing forecasts and to obtain within a reasonably short time results that were suitable for practical use. The evaluation of the scenarios resulted in the definition of the problem areas which could be used as guidelines for further R and D sponsoring.

26556 **Energy audits for industry.** Pinfold, D.R.M. *N.Z. Eng.;* **32**: No. 10, 229-231(15 Oct 1977).

The importance of energy and the need to avoid waste are no longer matters of argument. Everyone wishes his organization to do its part to help the nation conserve. Equally unquestionable is the growing magnitude of energy costs in the annual budgets of nearly every New Zealand company and organization. To enable management to deal effectively with this problem, an energy audit, a systematic program for analysis, measurement, and action, is proposed. The concept is simple, and it works. Energy prices have risen sharply compared with the operating costs, and now constitute an important and increasing portion of annual operating budgets. Therefore plan to use fuel more efficiently, and with less and less waste. Introduction of an energy audit system will help in understanding more about how fuel is used in the factory, office, and in transport, and it will help identify areas where waste occurs and where there is potential scope for improvement. It serves as a yardstick for judging the effectiveness of the energy-reduction program.

ENERGY SOURCES

REFER ALSO TO CITATION(S) 25620, 26544, 26545, 26546, 26547, 26548, 26549

EQUIPMENT AND PROCESSES

REFER ALSO TO CITATION(S) 26706

26557 (PB—269812) **Energy efficiency improvement target for SIC 34. Fabricated metal products. Volume 1. Draft target support document.** (Battelle Columbus Labs., Ohio (USA)). 28 Jun 1976. Contract FEA-CR-04-60610. 218p. NTIS PC A10/MF A01.

This proposed target is based on the best available information and is established at the level which represents the maximum feasible improvement in energy efficiency that the Fabricated Metal Products Industry (Standard Industrial Classification 34) can achieve by January 1, 1980, taking into account considerations of the technological feasibility and economic practicability of using alternative operating procedures and more energy efficient technologies. The draft target represents the percentage reduction in energy consumed per unit of output or activity that can be achieved between calendar year 1972 and January 1, 1980.

26558 (PB—269813) **Energy efficiency improvement target for SIC 34. Fabricated metal products. Volume 2. Revised target support document.** (Battelle Columbus Labs., Ohio (USA)). 15 Mar 1977. Contract FEA-CR-04-60610. 41p. NTIS PC A03/MF A01.

Following public hearings and review of the written comments which were submitted to FEA, the final targets for Fabricated Metal Products (Standard Industrial Classification 34) have been developed and are described in this report. They are intended to provide the basis for conservation activities undertaken in furtherance of the industrial energy conservation program.

26559 (PB—269823) **Energy efficiency improvement targets for primary metal industries. SIC 33. Volume I. Draft target support document.** (Battelle Columbus Labs., Ohio (USA)). 13 Aug 1976. Contract FEA-CR-04-60609. 247p. NTIS PC A11/MF A01.

In accordance with section 374 of the Energy Policy and Conservation Act (EPCA), Pub. L. 94-163, the Federal Energy Administration (FEA) proposed industrial energy efficiency improvement targets for the ten most energy-consumptive manufacturing industries in the United States. This proposed target is based on the best available information and is established at the level which represents the maximum feasible improvement in energy efficiency that the Primary Metal Industries (Standard Industrial Classification 33) can achieve by January 1, 1980 taking into account considerations of the technological feasibility and economic practicability of alternative operating procedures and more energy efficient technologies. The draft target represents the precentage reduction in energy consumed per unit of output or activity that can be achieved between calendar year 1972 and January 1, 1980.

26560 (PB—269824) **Energy efficiency improvement targets for primary metal industries. SIC 33. Volume II. Draft target support document. Appendices.** (Battelle Columbus Labs., Ohio (USA)). 13 Aug 1976. Contract FEA-CR-04-60609. 145p. NTIS PC A07/MF A01.

The appendix contains the detailed supporting documentation and rationale for the energy efficiency improvement goals for each of the component industries in SIC 33.

26561 (PB—269825) **Energy efficiency improvement targets for primary metal industries. SIC 33. Volume III. Final target report.** (Battelle Columbus Labs., Ohio (USA)). 10 Mar 1977. Contract FEA-CR-04-60609. 38p. NTIS PC A03/MF A01.

In accordance with section 374 of the Energty Policy and Conservation Act EPCA), Pub. L. 94-163, the Federal Energy Administration (FEA) proposed industrial energy efficiency improvement targets for the ten most evergy-consumptive manufacturing industries in the United States, and invited the oral and written presentation of views thereon by interested persons. Following public hearings and review of the written comments which were submitted to FEA, the final targets for Primary Metal Industries (Standard Industrial Classification 33) were developed and are described.

26562 (PB—269880) **Energy efficiency improvement target for SIC 32: stone, clay, and glass products. Volume 1. Draft report. Research report.** (Battelle Columbus Labs., Ohio (USA)). 25 Jun 1976. Contract FEA-CR-04-60608. 172p. NTIS PC A08/MF A01.

This proposed target is based on the best available information and is established at the level which represents the maximum feasible improvement in energy efficiency that the Stone, Clay, and Glass Products Industry (Standard Industrial Classification 32) can achieve by January 1, 1980, taking into account considerations of the technological feasibility and economic practicability of alternative operating procedures and more energy efficient technologies. The draft target represents the percentage reduction in energy consumed per unit of output or activity that can be achieved between calendar year 1972 and January 1, 1980.

26563 (PB—269881) **Energy efficiency improvement target for SIC 32: stone, clay, and glass products. Volume 2. Draft report. Appendices. Research report.** (Battelle Columbus Labs., Ohio (USA)). 25 Jun 1976. Contract FEA-CR-04-60608. 330p. NTIS PC A15/MF A01.

The appendix contains the detailed supporting documentation and rationale for the energy efficiency improvement goals for each of the component industries in SIC 32.

26564 (PB—269882) **Energy efficiency improvement target for SIC 32: stone, clay, and glass products. Volume 3. Draft report. Appendices. Research report.** (Battelle Columbus Labs., Ohio (USA)). 25 Jun 1976. Contract FEA-CR-04-60608. 308p. NTIS PC A14/MF A01.

The appendix contains the detailed supporting documentation and rationale for the energy efficiency improvement goals for each of the component industries in SIC 32.

26565 (PB—269883) **Energy efficiency improvement target for SIC 32: stone, clay, and glass products. Volume 4. Final report. Research report.** (Battelle Columbus Labs., Ohio (USA)). 10 Mar 1977. Contract FEA-CR-04-60608. 46p. NTIS PC A03/MF A01.

In accordance with section 374 of the Energy Policy and Conservation Act (EPCA), Pub. L. 94-163, the Federal Energy Adminsitration (FEA) proposed industrial energy efficiency improvement targets for the ten most energy-consumptive manufacturing industries in the United States, and invited the oral and written presentation of views thereon by interested persons. Following

public hearings and review of the written comments which were submitted to FEA, the final targets for Stone, Clay, and Glass Products (Standard Industrial Classification 32) were developed and are described in this report.

26566 Energy-saving absorption liquid chillers. *Kawasaki Giho;* **64**: No. 8, 110-113(Aug 1977). (In Japanese).

Kawasaki has successfully developed energy-saving type absorption liquid chillers. There are two systems for energy saving. One reduces the ratio of the energy input to the cooling capacity; e.g., 20% energy saving can be achieved by improving the refrigerating cycle. The other is to recover the thermal energy from process exhaust. Therefore, air conditioning results without additional fuel cost. With the demand for greater savings in energy consumption, a sizeable market for these machines is anticipated.

26567 Contribution to calculate the performance of multistage axial-flow compressors. Grahl, K.G. (Motoren- und Turbinen-Union G.m.b.H., Muenchen (Germany, F.R.)). *Z. Flugwiss. Weltraumforsch.;* **1**: No. 2, 116-122(Mar 1977). (In German).

A 'relative' off-design calculation method is proposed for industrial compressor development and its validity is checked against experimental data from different compressor builds. In addition, the impact of the choice of certain main parameter values (inlet displacement thickness, outlet angle, loss coefficient, camber, stagger) on the results of the off-design calculation for high and lower speeds has been examined and discussed. The simplified stability criterion used to determine the compressor surge line is based on a rotating stall theory.

26568 Current-state of off-design calculation methods for multistage axial-flow compressors. Grahl, K.G. (Motoren- und Turbinen-Union G.m.b.H., Muenchen (Germany, F.R.)). *Z. Flugwiss. Weltraumforsch.;* **1**: No. 1, 29-41(1977). (In German).

A detailed survey is made of current off-design calculation methods for multistage compressors. Potential flow calculation procedures, methods for determination of the end-wall boundary layers and semi-empirical loss models are presented in a form suitable for practical application. The compressor stall limit is found from a given stability criterion. - The practical application of off-design calculation for multistage compressors will be presented as a further publication.

WASTE HEAT RECOVERY AND UTILIZATION

REFER ALSO TO CITATION(S) 25839

26569 Development of high temperature dust collector. I. Ozaki, K.; Kodama, K.; Izumi, N.; Funahashi, K.; Hori, K.; Itoh, H. *Kawasaki Giho;* **64**: No. 8, 51-56(Aug 1977). (In Japanese).

Dust collectors removing dust from industrial flue gases have been recently required to increase their efficiency to meet severe emission regulation standards. New energy-saving processes are sought to facilitate the recovery of heat energy from flue gas down stream by hot side dust collectors. High temperature dust collection can satisfy present requirements. The basic characteristics of dust collection for C-heavy oil combustion gas are reported.

26570 Smoke tube boiler for heat recovery of hot exhaust gas. *Kawasaki Giho;* No. 63, 278-279(Mar 1977). (In Japanese).

Recently, for the purpose of saving energy, heat recovery apparatus is attracting greater attention. An apparatus making use of hot exhaust gas to generate steam or hot water is now in increasing demand. The KS-HR Type smoke tube boiler was developed to meet this demand.

INDUSTRIAL WASTE MANAGEMENT

REFER ALSO TO CITATION(S) 26569

26571 (NP—22973) **Waste oil fact sheet.** (Federal Energy Administration, Washington, D.C. (USA). Office of Energy Conservation and Environment). Jun 1976. 16p. NTIS.

Waste oil is generated from automotive and industrial sources at the rate of approximately 1,100,000,000 gallons each year. Although this amounts to somewhat less than 1 percent of the Nation's annual petroleum consumption, it does equate, nevertheless, to more than 70,000 barrels of oil per day, or 7 percent of the President's energy conservation goal for 1975. Yet today, as much as 50 percent of all waste oil generated in this country is lost from a resource recovery point of view through dumping, land spreading, road oiling, incineration and direct discharge to waterways and municipal sewers. Although this loss is primarily related to the adverse economics of various collection and recovery systems, especially in rural areas, the Federal Energy Administration (FEA) believes that better waste oil recovery is possible without Federal subsidization, and regards this objective as an important opportunity for energy conservation. FEA has developed and begun to implement a waste oil recovery program. This program has been designed to encourage greater waste oil collection and re-use, through state and local action, and public and industrial education programs. The purpose of this Fact Sheet is to summarize the issues, to consolidate and present the results of Federal research, to state FEA's position on these issues, and to outline the elements of our conservation program in this area.

26572 (PB—270591-T/SL) **Disposal of hazardous wastes, manual on hazardous substances in special wastes.** (North Atlantic Treaty Organization, Brussels (Belgium). Committee on the Challenges of Modern Society). Oct 1976. 418p. (NATO/CCMS—55).

The manual contains a selection of pure chemical substances relevant to waste. By selecting appropriate criteria, it is designed to illustrate part of the danger potential of these substances, at the same time providing pointers as to the possible effects of waste that contains these substances (special-waste). The remarks are complemented by information on the formation and disposal of such waste.

MUNICIPALITIES AND COMMUNITY SYSTEMS

MUNICIPAL WASTE MANAGEMENT

REFER ALSO TO CITATION(S) 26011

26573 Cryogenic tire granulation. McMillan, F. (Commonwealth Industrial Gases Ltd., Alexandria, Australia). pp T90-T91 of Treatment, recycle, and disposal of wastes. Johnston, I.R.W. (ed.). Clayton, Australia; Monash University (1975).

From 3. national chemical engineering conference; Mildura, Victoria, Australia (20 Aug 1975).

See CONF-750897—.

A method for recycling the materials in discarded automobile tires is described. It consists of cooling the waste tires in a cryogenic fluid, e.g., liquid nitrogen, to a temperature below the rubber embrittlement point, crushing the embrittled tires, magnetic separation of steel segments in crushed material, and flotation separation of fibers and rubber in remaining material. Many potential uses of the recovered rubber crumb, fiber, and steel scrap are listed. It is concluded that cryogenic processing of scrap tires is economically feasible. (LCL)

26574 (NTIS/PS—77/0790) **Solid waste disposal economics (a bibliography with abstracts). Report for 1964—September 1977.** Cavagnaro, D.M. (National Technical Information Service, Springfield, Va. (USA)). Sep 1977. 232p.

The topics cited in the bibliography include all aspects of the economics of solid waste disposal and abatement, covering studies concerning industries, transportation, urban planning, and recycling. Topics such as profitability of waste recovery and the economics of using new solid waste processing and disposal techniques and their impact on handling costs are included. (This updated bibliography contains 227 abstracts, 102 of which are new entries to the previous edition.)

26575 (DOE-tr—26) **Where does the garbage go.** Braun, R. Nov 1976. Translation: source information not available. 140p. Dep. NTIS, PC A07/MF A01.

The Swiss federal laws governing waste management and environmental protection are summarized. The origin and composition of municipal and industrial wastes is summarized and waste processing or disposal options available are tabulated. A tabulation is made by canton of the waste disposal sites, the types of wastes acceptable, the processing method, and possible expansions planned. Each listing also carries the name of the organization responsible for waste disposal, the name of the manager and a telephone number. The sites treating special wastes such as industrial emulsions and chemicals from waste streams, scrap automobiles, sludges containing heavy metals, animal carcasses, etc. are then tabulated. A separate tabulation lists types of special wastes with a reference to sites processing this type of waste. Federal and canton offices and private organizations and associations having information on waste management are listed. (JSR)

26576 Thermoradiation treats sewage sludge. Brandon, J.R. (Sandia Labs., Albuquerque, NM). *Water Sewage Works;* **123**: No. 9, 126-129(Sep 1976).

Research at the Sandia Laboratories on the inactivation of microorganisms in sewage sludge by the combined use of heat and ionizing radiation is described. Data are presented on the effectiveness for inactivation of various bacteria of varying radiation doses. The cost of sludge thermoirradiation, a proposed design for a pilot plant for sludge treatment, and possible agricultural uses, i.e., soil conditioners and animal feeds, of dried thermoirradiated sludge are discussed. (LCL)

ADVANCED AUTOMOTIVE PROPULSION SYSTEMS

REFER ALSO TO CITATION(S) 26495

SPARK-IGNITION

REFER ALSO TO CITATION(S) 26588

EXTERNAL COMBUSTION ENGINES

STIRLING CYCLE

26577 (BERC/RI—78/3) **Stirling engine: an option for underground mines.** Marshall, W.F. (Department of Energy, Bartlesville, Okla. (USA). Bartlesville Energy Research Center). Mar 1978. 8p. Dep. NTIS, PC A02/MF A01.

The use of heat engines for powering mobile equipment in underground mines offers advantages over electric power in terms of mobility and electric shock hazards. However, exhaust is discharged into the working environment; thus there is a potential hazard associated with toxic combustion products. Although diesel engines are in use in underground mines, other heat engines might be considered for use because of potentially lower emission rates. The Stirling engine is a possible alternative to the diesel because it shows promise as a low emission, high power density engine. In order to assess the potential of the Stirling for mining applications, performance data are required. To fill this need, data on the composition of the exhaust from a Stirling engine were obtained. The results of this work indicate that the Stirling engine compares very favorably with "low emission" diesels with respect to emissions characteristics.

26578 (CONS/1011—22) **Materials technology assessment for Stirling engines.** Stephens, J.R.; Witzke, W.R.; Watson, G.K.; Johnston, J.R.; Croft, W.J. (National Aeronautics and Space Administration, Cleveland, Ohio (USA). Lewis Research Center; Army Materials and Mechanics Research Center, Watertown, Mass. (USA)). Oct 1977. Contract EX-76-A-31-1011. 16p. (CONF-771037—2; NASA-TM—73789). Dep. NTIS, PC A02/MF A01.

From ERDA contractors' coordination meeting; Detroit, MI, USA (4 Oct 1977).

A materials technology assessment of high temperature components in the improved (metal) and advanced (ceramic) Stirling engines was undertaken. The objectives of the assessment were to evaluate the current state-of-the-art of metals and ceramics, identify materials research and development required to support the development of automotive Stirling engines, and to recommend materials technology programs to assure material readiness concurrent with engine system development programs. The most critical component for each engine is identified, and a discussion of some of the material problem areas is presented.

ELECTRIC-POWERED SYSTEMS

REFER ALSO TO CITATION(S) 26582

26579 (CONS/5053—1) **Evaluation and recommendation of electric and hybrid vehicle performance standards. Final report.** (Society of Automotive Engineers, Inc., Warrendale, Pa. (USA)). 30 Sep 1977. Contract EC-77-C-01-5053. 24p. Dep. NTIS, PC A02/MF A01.

A summary is presented of deliberations and recommendations of a task force having the following objectives: (1) identify an acceptable set of performance standards based on the work of two ERDA contractors; (2) identify and revise those performance standards which were found to be unacceptable; (3) identify the omission of important performance standards and suggest procedures to develop them; and (4) provide the task force rationale for the recommendations presented above. Better vehicle performance specifications can be developed as more reliable test data and field experience becomes available. In particular, safety-related vehicle component performance requirements should be defined after crash tests are run with this class of vehicle. The Task Force recommends that ERDA identify the development of vehicle performance requirements as a specific task which is carried forward concurrently with the electric and hybrid vehicle test and demonstration program.

26580 (HCP/M1011—01) **State-of-the-art assessment of electric and hybrid vehicles.** (National Aeronautics and Space Administration, Cleveland, Ohio (USA). Lewis Research Center). Jan 1978. Contract EX-76-A-31-1011. 596p. Dep. NTIS, PC A25/MF A01.

Data are presented that were obtained from the electric and hybrid vehicles tested, information collected from users of electric vehicles, and data and information on electric and hybrid vehicles obtained on a worldwide basis from manufacturers and available literature. The data and information thus obtained were evaluated and compiled to present the state-of-the-art of electric and hybrid vehicles. The data given include: (1) information and data base (electric and hybrid vehicle systems descriptions, sources of vehicle data and information, and sources of component data); (2) electric vehicles (theoretical background, electric vehicle track tests, user experience, literature data, and summary of electric vehicle status); (3) electric vehicle components (tires, differentials, transmissions, traction motors, controllers, batteries, battery chargers, and component summary); and (4) hybrid vehicles (types of hybrid vehicles, operating modes, hybrid vehicle components, and hybrid vehicle performance characteristics).

26581 (UCRL—13805) **Electric Hybrid Vehicle Program contractors' coordination meeting: summary, oversight, and review.** (California Univ., Livermore (USA). Lawrence Livermore Lab.). 19 Dec 1977. Contract W-7405-ENG-48. 28p. Dep. NTIS, PC A03/MF A01.

On December 5 to 7, 1977, Transportation Energy Conservation of the Department of Energy (DOE) held the Electric and Hybrid Vehicle Program Contractor' Coordination Meeting at Reston, Virginia. The purpose of the three-day meeting was for the various DOE contractors engaged in electric and hybrid vehicle (EHV) research, development and demonstration work to report and discuss their activities. The Lawrence Livermore Laboratory, University of California, was the Program Coordinator. The material is presented in two parts: (1) Oversight and Overview of the Conference: Recommendations For Future Meetings; and (2) Principal Points Made By Participants In Their Presentations. A copy of the Agenda is attached. Staff of DOE and the participating contractors cooperated fully with our efforts. Numerous informal discussions during the conference served to identify changes to be considered for future meetings and these are presented in Part 1.

HYBRID SYSTEMS

REFER ALSO TO CITATION(S) 26579, 26580, 26581

26582 (COO/2835—1) **Hybrid vehicle simulation program (Rev. 1).** Artiles, A.F. (Mechanical Technology, Inc., Latham, N.Y. (USA)). Sep 1977. Contract EY-76-C-02-2835. 77p. NTIS, MF A01.

Portions of document are illegible.

A digital computer program for simulation of a hybrid electric vehicle is presented. User's instructions for preparing input for and simulating the performance of a hybrid vehicle of arbitrary configuration are provided. Sample simulation calculations for a representative electric vehicle as well as for a vehicle powered by a representative Stirling engine are included, and the output is discussed.

FLYWHEEL PROPULSION

26583 (PB—269607) **Increased fuel economy in transportation systems by use of energy management: third year's program. Final report, 1 May—1 July 1976.** Beachly, N.H.; Frank, A.A. (Wisconsin Univ., Madison (USA). Engineering Experiment Station). Jul 1976. Contract DOT-OS-30112. 90p. NTIS PC A05/MF A01.

The report covers the detailed design, construction, and preliminary evaluation of a Flywheel Energy Management Powerplant (FEMP) installed in a Pinto. The vehicle has been built to experimentally verify performance simulations and to allow the practical aspects of a real flywheel vehicle to be studied.

VEHICLE DESIGN FACTORS

BODY AND CHASSIS

26584 **Resonaflex, the anticorrosive multi-purpose plate for thermal and acoustic insulation.** Pregler, R. (Nobis, Hohenbrunn (Germany, F.R.)). *ETR (Eisenbahntech. Rundsch.);* **25**: No. 9, 541-542(Sep 1976). (In German).

A novel type of insulating plate for thermal and acoustic insulation is reported on. The main field of application of this insulating material will be vehicle engineering, but recently it has also been used in buildings. The new insulating plates fulfil all physical requirements and have great advantages with regard to mechanical technology and treatment in workshops and small factories.

ENGINE-TRANSMISSION MATCHING

26585 (MTI—78TR11) **Traction drives: a review of their configurations and considerations for their selection for automotive applications. Technical report.** Dean, P. (Mechanical Technology, Inc., Latham, N.Y. (USA)). Dec 1977. Contract EY-76-C-02-2835. 39p. Dep. NTIS, PC A03/MF A01.

The objective of the review presented was to obtain data on all of the traction drives that are commercially available in the United States. A secondary objective was to select those drives that might have potential for use in the main drive train of automotive vehicles. In order to achieve the secondary objective, it was necessary to identify all of those characteristics of each drive that concerns the way in which it would perform in an automotive application. A brief discussion is given of each of the more important of these characteristics. There is also a sketch of each of the general configurations of traction drives commercially available. At this time, there is not enough data available about the characteristics of the power source or of the vehicle to make possible a selection of a specific type of drive for further study.

26586 (PB—269591) **Automobile drivelines. Final report, June—December 1974.** Colello, R.G. (Department of Transportation, Cambridge, Mass. (USA). Transportation Systems Center). May 1977. 56p. (TSC-OST—77-34; TSC-OST—75-35). NTIS PC A04/MF A01.

This study assesses automobile driveline components and configurations, quantifying their performance as possible in the context of such current issues as fuel economy, exhaust emission reduction, safety, driveability, production costs and lead times, and engine life. The current and projected driveline technology is described. The results of simulation studies using the DOT/TSC Vehicle Simulation Program to analyze vehicles incorporating various driveline components and configurations in relation to fuel economy, acceleration, emissions and other factors of interest are also reported.

ENGINE SYSTEM

REFER ALSO TO CITATION(S) 26578

26587 (PB—270995) **Diagnostic motor vehicle inspection demonstration projects, program engineering support. Volume 7. Appendix f. Fuel economy evaluation. Final report November 1974—December 1976.** Joncas, K.P. (Avco Systems Div., Wilmington, Mass. (USA)). Jul 1977. Contract DOT-HS-5-01037. 157p. (AVSD—0022-77-RR(Vol.7)).

The performance of this task has been both challenging and frustrating - challenging because it involved wrestling with an interesting and current technical topic, frustrating because of inability to reach agreement on the achievable goals of a fuel economy program within the demonstration projects. Inasmuch as there are several schools of thought on the why of a fuel economy program, this report presents several options on the how of such a program.

26588 (UCRL—79534) **Theoretical model for two-phase fuel injection in stratified charge engines.** Haselman, L.C.; Westbrook, C.K. (California Univ., Livermore (USA). Lawrence Livermore Lab.). May 1977. Contract W-7405-ENG-48. 58p. (CONF-780208—1). Dep. NTIS, PC A04/MF A01.

From Society of Automotive Engineers International Automotive Engineering Congress and Exposition; Detroit, MI, USA (Feb 1978).

A theoretical model was developed for calculations of the evolution of fuel injected into internal combustion engine chambers. Fuel injection in the form of a gaseous jet and in the form of a liquid droplet spray are considered. The model uses the basic equations of conservation of mass, momentum, and energy in both the gaseous and liquid phases. Applications in two dimensional symmetry of the gaseous jet form of the numerical model are described in stagnant and swirling air flows. The liquid droplet spray model, including coupling between the droplets and the gas phase medium, is described. Applications of the two phase model are described for the case of axially symmetric injection. Finally, the liquid spray model and the gas jet model are applied to the same conditions, leading to a general assessment of the ranges of validity of the gas jet model.

26589 **Newly developed UTR type marine reheat boiler.** Itoh, S.; Shindoh, I.; Ohshika, T. *Kawasaki Giho;* No. 63, 187-194(Mar 1977). (In Japanese).

Since 1970, Kawasaki has delivered seven VLCCs with a UFR marine reheat boiler developed through Kawasaki's own techniques. They are all in service and performing satisfactorily. With the increasing price of fuel oil, the reheat plant is being appraised as the most promising among the many kinds of steam propulsion plants. In addition, further reduction of initial cost is being required with simplification of operation and maintenance. Considering the above circumstances, on the basis of its own latest techniques and long experience in reheat boilers, Kawasaki has newly developed an advanced type reheat boiler--the UTR type marine reheat boiler. The UTR type marine reheat boiler has the following main features: (1) single furnace and two-gas pass; (2) superheater steam temperature control by simmering type attemperator and reheat steam temperature control by damper; and (3) smaller size and weight savings. The first VLCC with UTR type marine reheat boiler was delivered in Sept. 1976.

ALTERNATIVE FUELS

26590 (AD-A—043323) **Corrective action program for bromochloromethane-containing fire-safe diesel fuel. Final report.** Weatherford, W.D. Jr; Wright, B.R. (Southwest Research Inst., San Antonio, Tex. (USA). Army Fuels and Lubricants Research Lab.). Sep 1976. Contract DAAG53-76-C-0003. 75p. (AFLRL—81). NTIS PC A04/MF A01.

Following a laboratory-engine endurance test of bromochloromethane (BCM) 'fire-safe fuel' (FSF) in a 12-cylinder, air-cooled, four-cycle AVDS 1790-2C diesel engine conducted by Teledyne Continental Motors, a multifaceted experimental program was originated by MERADCOM/AFLRL (Mobility Equipment Research and Development Command/Army Fuels and Lubricants Research Laboratory) to establish whether or not 'fixes' could be developed to overcome the problems that caused the engine endurance test to be terminated after 150 rather than the intended 400 operating hours. Recapitulation of test events, detailed post-test examinations of engine parts and used lubricant samples, and follow-through experimental studies by MERADCOM/AFLRL confirmed or indicated plausible mechanisms for the observed difficulties. First, the fuel pump plunger rod sticking problem was confirmed to have been caused by corrosion at the fuel-oil interface; second, the fuel injector valve sticking was caused by a lacquer-like deposit; third, the fuel injector nozzle holes had become substantially enlarged and elongated by predominately corrosive mechanisms; fourth, excessive distress experienced by the oil-control piston ring appeared to have resulted from combined effects of stress corrosion cracking caused by HCl and scuffing caused by inadequate lubrication and fifth, oil filter plugging was found to have resulted from the formation of halon by-product and wear-metal-containing sludge in the lubricant.

26591 (BERC/TPR—77/8) **Experiments with novel fuels for diesel engines.** Marshall, W.F. (Department of Energy, Bartlesville, Okla. (USA). Bartlesville Energy Research Center). Feb 1978. 7p. Dep. NTIS, PC A02/MF A01.

Engine tests were conducted with two fuels that would be considered as novel for use in diesel engines. The fuels, methanol and a water/diesel fuel emulsion, were used in this study because of their potential for reductions in exhaust emissions. The test results showed that these fuels yield no advantages over standard diesel fuel with respect to emissions of unburned hydrocarbons and oxides of nitrogen. Although smoke and carbon monoxide emissions were reduced with the use of the water/fuel emulsion, the same effect could also have been achieved via engine adjustment.

MATERIALS

26592 **Study of self-diffusion in dense hydrogen gas by quasielastic incoherent neutron scattering.** Chen, S.H.; Postol, T.A.; Skoeld, K. (Massachusetts Institute of Technology, Cambridge, Massachusetts 02139). *Phys. Rev., A;* **16**: No. 5, 2112-2119(Nov 1977).

Incoherent quasielastic scattering of neutrons from hydrogen gas has been measured at room temperature and 78 °K in a range of pressures from 100 to 2000 atm. We present in some detail the data-reduction procedure which allows us to extract the van Hove self-correction function S/sub s/(Q, ω). We then extract the linewidth of the self-correlation function by assuming a Lorentzian line shape. By extrapolating to the small-Q limit, we obtain the macroscopic self-diffusion coefficient as a function of density and temperature. We compare the results with the hard-sphere Enskog theory and conclude that there is considerable enhancement over the Enskog values at higher densities.

26593 **Role of materials in energy production.** Polmear, I.J. (Monash Univ, Clayton, Victoria, Aust). *J. Aust. Inst. Met.;* **21**: No. 2-3, 66-87(1976).

After a brief review of the world's energy position, the paper considers current and future ways of producing and storing energy. The essential technology is summarized, after which attention is directed at materials problems that are either limiting efficiency, or preventing the exploitation of some sources of energy. The future needs of society for abundant, clean and cheap energy provides the largest single challenge to materials scientists and engineers. 101 refs.

METALS AND ALLOYS

REFER ALSO TO CITATION(S) 26578, 26710

PREPARATION AND FABRICATION

REFER ALSO TO CITATION(S) 25643, 25822, 26069, 26624

26594 (K/CSD/INF—77/17) **HEATING5 analysis of a welding problem.** Giles, G.E.; Elrod, D.C.; Siman-Tov, I.I. (Union Carbide Corp., Oak Ridge, Tenn. (USA). Nuclear Div.). 1977. Contract W-7405-ENG-26. 26p. (CONF-770965—1). Dep. NTIS, PC A03/MF A01.

From Symposium and workshop on moving boundary problems; Gatlinburg, TN, USA (26 Sep 1977).

The geometry and thermal properties of a circumferential weld are modeled. The three parameters that were determined empirically were: (1) the time and spatial variation in heat generation; (2) the conductivity of the molten material; and (3) the anisotropic conductivity (simulating gap resistance). The heat generation alone appeared to control the temperature field outside of an approximate circle of radius r_1 around the weld. Radius r_1 is less than the distance from the weld to the closest thermocouple. The area of concern in the thermal stress analysis lies outside r_1. Within this circle the molten conductivity and the anisotropic conductivity of the solid also became major influences on the temperature field. By matching the thermocouple temperature and the melt zone, the authors feel that the temperature field is accurately represented by the computed results. (GHT)

26595 (Y—2101) **Development of an aging integrator for uranium-0.75 weight percent titanium alloy part aging control.** Howington, L.C. (Oak Ridge Y-12 Plant, Tenn. (USA)). Dec 1977. Contract W-7405-ENG-26. 19p. Dep. NTIS, PC A02/MF A01.

An instrumentation system (Aging Integrator) has been developed to provide more precise control of the heat-treatment process used on uranium-0.75 wt.% titanium alloy material. The Aging Integrator calculates the integral of a predetermined aging function to control the aging period in the heat-treatment process. This control was employed to compensate for discrepancies caused by variations in heatup times, furnace-control fluctuations, and disagreement as to the temperature at which aging actually starts. Although the Aging Integrator hardware has been installed and satisfactorily tested on a production-area furnace, sufficient data to estimate a statistically sound aging integration function will not be available for approximately one year.

26596 **High-temperature and ionization-induced effects in lithium-doped MgO single crystals.** Chen, Y.; Tohver, H.T.; Narayan, J.; Abraham, M.M. (Solid State Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830). *Phys. Rev., B;* **16**: No. 12, 5535-5542(15 Dec 1977).

Thermal quenching of Li-doped MgO crystals from temperatures in excess of 1300 K results in the formation of $[Li]^0$ defects, which are substitutional lithium ions each with a bound hole at a neighboring oxygen site. Unlike $[Li]^0$ defects generated at low temperatures by a low dose of ionizing radiation, those formed by quenching are stable against hole release well above room temperature. This stability is much higher than for all previously reported hole defects in alkaline-earth oxides. These stable $[Li]^0$ defects have also been produced by high-dose electron irradiations at both 290 and 85 K, with formation cross sections of $\sim 10^5$ and 10^3 b, respectively. The magnitude and temperature dependence of the cross section suggests a radiation-induced diffusion, rather than an elastic collision, process as the production mechanism. These defects anneal at 450 K in the electron-irradiated crystals and 830 K in the quenched ones. A model involving localized regions of high lithium concentration is proposed in order to explain the stability of the bound hole at the $[Li]^0$ defect.

26597 **Use of general purpose software in casting solidification simulation.** Erickson, W.C. (Los Alamos Scientific Lab., NM). *Metall. Trans., B;* **8**: 93-97(Mar 1977).

Computer simulation of casting solidification has been developed to a degree that allows its use in industrial applications. This has been accomplished through the use of numerical techniques, the high-speed digital computer, and the development of procedures which eliminate previous assumptions of temperature-independent thermal properties, zero melt superheat, and intimate contact at all interfaces. However, for computer simulation to be a useful, economic tool, the manpower required to prepare a problem for the computer and to analyze the results must be minimized. These can be achieved by including in the programmatic goals of the project the use of generalized computer programs, simple data input, and easy-to-analyze computer output. One means of accomplishing this involves the use of general-purpose heat transfer programs, preprocessing computer programs to aid in data input, and color microfilm output. Such a procedure is described, using a copper, flanged-barrel casting problem to demonstrate the versatility and ease of data analysis possible with this approach. 3 figures, 3 tables.

MECHANICAL PROPERTIES

REFER ALSO TO CITATION(S) 25884, 25962, 26430, 26443

26598 (NTIS/PS—77/0803) **Titanium and titanium alloy creep (a bibliography with abstracts). Report for 1964—September 1977.** Smith, M.F. (National Technical Information Service, Springfield, Va. (USA)). Sep 1977. 173p.

Research is cited on creep of titanium and its alloys relative to composition, stress corrosion, fatigue, fracture, and microstructure. Tests are described on varying conditions of temperatures, pressures and atmospheres. Processing and metalworking are covered for their relationship to creep resistance. Many reports deal with applications to aircraft, spacecraft and nuclear reactors. (This updated bibliography contains 168 abstracts, 35 of which are new entries to the previous edition.)

26599 **Some observations on oxygen and carbon potentials in U—Pu—O and U—Pu—C systems.** Tetenbaum, M. (Argonne National Lab., IL). pp 179-188 of Advanced LMFBR fuels. Leary, J.; Kittle, H. (eds.). La Grange Park, IL; American Nuclear Society (1977).

From International meeting on advanced LMFBR fuels; Tucson, AZ, USA (10 Oct 1977).

See CONF-771008—.

Measurements to characterize the effect of plutonium valency on oxygen potential have been made at 2050 K for hypostoichiometric U-Pu-O fuel compositions having plutonium-to-metal ratios ranging from 0.15 to 0.30. The data indicate that oxygen potential is dependent on the plutonium-to-metal ratio and therefore, do not support the hypothesis that $\Delta G(O_2)$ values for the U-Pu-O system are a function of the metal whose oxidation state is changing. Equilibrium of the U-Pu-C solid solution system, where $Pu/(U + Pu) = 0.2$ and $C/(U + Pu) = 0.98$ with a carrier gas having a carbon activity of approximately 0.62 at 2050 K resulted in the formation of a residue of composition $C/(U + Pu) = 1.05$.

PHYSICAL PROPERTIES

REFER ALSO TO CITATION(S) 26069

26600 **Systematics in the Knight shift of rare-earth monopnictides.** Jena, P.; Lam, D.J. (Argonne National Laboratory, Argonne, Illinois 60439). *Phys. Rev., B;* **17**: No. 1, 1-5(1 Jan 1978).

The Knight shifts at nonmagnetic sites in the rare-earth group-VA intermetallic compounds have been analyzed systematically in terms of two major contributions: (i) A largely temperature-dependent part, K/sub f/ due to localized 4f electrons and (ii) a temperature-independent part, K_0 due to s-like electrons. It is shown that while K_0 is relatively constant with changing rare-earth constituent of the compound, it depends sensitively on the atomic number, A, of the group-VA element. In all the compounds studied, K_0 of a nonmagnetic ion varies approximately as A/sup 5/4/. This power law is shown to be largely due to the orthogonalization of the conduction electrons to the occupied core orbitals of the nonmagnetic ion. The available data on Knight shifts in transition and actinide-metal compounds fail to exhibit similar systematics.

26601 **Temperature fluctuations in freely suspended tin films at the superconducting transition.** Ketchen, M.B.; Clarke, J. (Department of Physics, University of California and Materials and Molecular Research Division, Lawrence Berkeley Laboratory, Berkeley, California 94720). *Phys. Rev., B;* **17**: No. 1, 114-121(1 Jan 1978).

We have used a superconducting-quantum-interference-device voltmeter to measure the spectral density S/sub v/(f) of the voltage noise across current-biased tin films at the superconducting transition. Each film was freely suspended between two thermal clamps a distance L apart in a vacuum can. The transverse dimensions of the films were small compared with (D/f)/sup 1/2/ at the frequencies of interest (D is the thermal diffusivity), so that the heat flow was one dimensional. A thin layer of lead was evaporated on some of the tin films to leave an uncoated middle region of length l. S/sub v/(f) was proportional to the square of the bias current and to the square of the temperature coefficient of resistance, indicating that the noise was generated by temperature fluctuations. Behavior is in reasonable agreement with the predictions of an equilibrium temperature-fluctuation model in which the equal-time temperature fluctuations are spatially uncorrelated. The magnitude of S/sub v/(f) is within a factor of 2 or 3 of the model predictions. The autocorrelation function of the voltage noise was obtained from the time derivative of the response of the film to a step function in power. The cosine transform of the autocorrelation function was in excellent agreement with the measured spectral density. These results are in marked contrast with those obtained for normal and superconducting films supported by substrates, for which a model is required with spatially correlated fluctuations. We conclude that the 1/f noise for

films on substrates is mediated by an interaction between substrate and film.

26602 Estimate of density-of-states changes with disorder in A-15 superconductors. Wiesmann, H.; Gurvitch, M.; Ghosh, A.K.; Lutz, H.; Kammerer, O.F.; Strongin, M. (Brookhaven National Laboratory, Upton, New York 11973). *Phys. Rev., B;* **17**: No. 1, 122-125(1 Jan 1978).

Data are presented which show that the density of states changes dramatically, as does T/sub c/, in both Nb_3Sn and Nb_3Ge samples which were disordered by α-particle irradiation. The density of states is derived from the strong-coupling modifications to the theory of type-II superconductors along with measurements of (dH/sub c//dT)/sub T c/ and the residual normal-state resistance rho_0.

26603 High-temperature spin dynamics in an amorphous ferromagnet. Tarvin, J.A.; Shirane, G.; Birgeneau, R.J.; Chen, H.S. (Brookhaven National Laboratory, Upton, New York 11973). *Phys. Rev., B;* **17**: No. 1, 241-248(1 Jan 1978).

We have carried out an inelastic-neutron-scattering investigation of the high-temperature spin-wave excitations and the critical dynamics in the amorphous ferromagnet $(Fe_{85}Ni_{35})_{75}P_{16}B_6Al_3$ (T/sub C/ = 572 K). Well-defined spin-wave excitations are observed for wave vectors 0.06 < or = q < or = 0.18 A^{-1} and for temperatures up to 555 K. The spin-wave dispersion relation over this q range is well described by the expression $h\omega = \Delta + Dq^2$, where Δ (T = 0) $\simeq$ 0.05 meV and D = 115[1-0.45 (T/T/sub C/)/sup 5/2/] meV A^2; the 5/2 power law appears to hold up to 450 K. Measurements at T = 450 K show that the spin-wave damping is consistent with the Heisenberg-model prediction $\Gamma(q) \sim q^4 \ln^2[k/sub B/T/h\omega (q)]$. In the critical region the spin-wave stiffness is found to follow the power law D ~ (1-T/T/sub C/)/sup 0.5tsplus-or-minusts0.1/ for 0.02 < or = 1-T/T/sub C/ < or = 0.2, while at T/sub C/ the energy width is consistent with Γ/sub C/(q) ~ q/sup 2.7tsplus-or-minusts0.2/ for 0.05 < or = q < or = 0.18 A^{-1}. These results are in satisfactory agreement with dynamical scaling theory for the Heisenberg ferromagnet and further they are in good accord with similar, albeit more-detailed, measurements in the crystalline transition metals Fe, Co, and Ni.

26604 Self-consistent screening of a positive muon in a spin-polarized electron gas. Jena, P.; Singwi, K.S.; Nieminen, R.M. (Physics Department and Materials Research Center, Northwestern University, Evanston, Illinois 60201). *Phys. Rev., B;* **17**: No. 1, 301-307(1 Jan 1978).

The electron spin-density distribution around a positive muon has been calculated self-consistently for a range of metallic densities using the spin-density functional formalism. The enhancement of the spin density at the μ^+ site over the ambient polarization is found to be considerably smaller than the corresponding charge-density enhancement. The results are used to estimate the hyperfine field at interstitial positive-muon sites in ferromagnetic Fe, Co, Ni, and Gd. Comparison is made with the most recent experimental data.

26605 Induced magnetization density in α-uranium. Maglic, R.C.; Lander, G.H.; Mueller, M.H.; Kleb, R. (Argonne National Laboratory, Argonne, Illinois 60439). *Phys. Rev., B;* **17**: No. 1, 308-311(1 Jan 1978).

The magnetic form factor of the induced magnetic moments in α-uranium [0.0049μ/sub B//(U atom) at 78 K with an applied field of 7 T] has been measured with polarized neutrons. The experimental points are significantly below the form factors determined for a number of uranium compounds. We interpret the results in terms of wide 5f bands and a partial quenching of the orbital magnetic moment.

26606 Lithium local-orbital energy bands using Kohn-Sham and near- Hartree-Fock exchange. Jennison, D.R. (Department of Physics and Materials Research Laboratory, University of Illinois, Urbana, Illinois 61801). *Phys. Rev., B;* **16**: No. 12, 5147-5152(15 Dec 1977).

The local-orbitals procedure is found to work well with simple metals. Energy bands have been calculated from bcc lithium local orbitals using both Kohn-Sham and near Hartree-Fock exchange. A free-electron correlation model due to Overhauser was adapted to approximately correct the Hartree-Fock bands for correlation effects. These corrected bands agree well with the Kohn-Sham bands, and both results agree well with previous theoretical results. Comparisons to experimental Auger spectra, soft-x-ray emission and absorption spectra, and Fermi-surface measurements are made.

26607 Emission and absorption x-ray edges of Li. Callcott, T.; Arakawa, E.T.; Ederer, D.L. (Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830). *Phys. Rev., B;* **16**: No. 12, 5185-5192(15 Dec 1977).

The K x-ray emission edge of Li is measured between 85 and 490 K and analyzed to obtain the temperature dependences of the edge position and of a Gaussian edge-broadening function. Full width at half-maximum edge widths range from 0.22 +- 0.05 eV at 85 K to 0.38 +- 0.05 eV at 440 K. Edge positions shift from 54.81 +- 0.02 eV at 85 K to 54.86 +- 0.02 eV at 440 K and to 54.91 +- 0.02 eV after melting. Emission and absorption spectra measured with the same spectrometer establish a 0.10 +- 0.02 eV separation between the emission and absorption edges. These results are compared with recent theories describing incomplete lattice relaxation about the core hole. We conclude that for a core-hole lifetime of 0.016 to 0.030 eV the theories give a satisfactory explanation of the premature peak in the emission spectra. We suggest also that phonon—core-hole interactions provide the dominant edge-broadening mechanism, and that many-body effects are small.

26608 X-ray photoemission spectra of the valence bands of the 3d transition metals, Sc to Fe. Ley, L.; Dabbousi, O.B.; Kowalczyk, S.P.; McFeely, F.R.; Shirley, D.A. (Materials and Molecular Research Division, Lawrence Berkeley Laboratory and Department of Chemistry, University of California, Berkeley, California 94720). *Phys. Rev., B;* **16**: No. 12, 5372-5380(15 Dec 1977).

High-resolution x-ray-photoemission valence-band (VB) spectra are presented of the 3d transition metals, Sc to Fe. The measurements were conducted under ultra-high-vacuum conditions using polycrystalline samples. In the hcp elements Sc and Ti the main peaks in the valence bands are identified and compared with the results of band-structure calculations. Some rigidity is observed in the Sc and Ti bands as well as in the V and Cr bands. The expected two-peak structure for V and Cr is observed. In chromiun we also observed a relatively low density of states at the Fermi energy. The VB spectrum for chromium is compared to theoretical predictions, and we present an assignment of the Cr symmetry-point energies. Our valence-band spectrum of Mn is quite similar to that of Huefner and Wertheim and our spectrum of Fe is in good agreement with that observed by Hoechst, Goldman, and Huefner. These iron VB spectra agree qualitatively with expectations based on band models of ferromagnetism. It is observed that the VB spectrum of bcc iron may be constructed to agree within an energy scale factor from two bcc Cr VB's shifted to account for spin polarization. We also deduce the symmetry-point energies in iron.

26609 Measurement of the thermal expansion coefficient of nickel from 300 to 1000 K and determination of the power-law constants near the Curie temperature. Kollie, T.G. (Metals and Ceramics Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830). *Phys. Rev., B;* **16**: No. 11, 4872-4881(1 Dec 1977).

A fused quartz dilatometer was used to measure the thermal-expansion coefficient α of nickel between 300 and 1000 K. Measurements on National Bureau of Standards certified copper and tungsten standards with the dilatometer established the uncertainty in the α measurements on nickel as +- 0.8% (+- 0.10 x 10^{-6} K^{-1}), except within +- 2 K of the Curie temperature T/sub C/ where the uncertainty was about +- 1.6%. Results of 38 investigations of the expansion of nickel reported in the literature were analyzed critically, resulting in a compilation of α of nickel from 0 to 1500 K. Theories of thermal expansion were employed to separate α into its paramagnetic α/sub p/ and magnetic α/sub m/ components. The calculated values of α/sub m/ near T/sub C/ were fitted to the power-law equation, α/sub m/ = A (t/sup -a/ - 1) a^{-1} + B, that describes critical phenomena near the critical temperature [t = (T - T/sub C/) T^{-1}/sub C/]. It was demonstrated that the critical exponents above and below T/sub C/, a and a', respectively, are the same as those derived from specific-heat measurements and that a = a' = -0.093 (+- 0.010) in agreement with scaling laws of critical phenomena.

26610 Magnetic excitations in the weak itinerant ferromagnet MnSi. Ishikawa, Y.; Shirane, G.; Tarvin, J.A.; Kohgi, M. (Brookhaven National Laboratory, Upton, New York 11973). *Phys. Rev., B;* **16**: No. 11, 4956-4970(1 Dec 1977).

Magnetic excitations in an intermetallic compound MnSi have been studied by neutron scattering. At 5 K in a magnetic field of 10 kOe, well-defined spin-wave excitations have been observed below 2.5 meV. The dispersion relation is almost isotropic and is hω/sub q/(meV = 0.13 + 52q^2(A^{-2}) in the [100] direction. Above 3 meV, the excitation linewidth increases substantially, suggesting that the dispersion relation merges into the Stoner continuum. The Stoner excitations, which extend over almost all the Brillouin zone, show a broad peak on the extension of the spin-wave dispersion relation. The spin-wave excitation renormalizes with increasing temperature and collapses into critical scattering above 40 K. On the other hand, the excitation in the Stoner continuum is affected little by temperature; the excitations are qualitatively the same at T/T/sub N/ = 10 as at 5 K. The Stoner boundary energy decreases with increasing temperature. The results provide us with the first example of magnetic excitations in a weak itinerant ferromagnet.

26611 Electron-phonon spectral function and mass enhancement of niobium. Harmon, B.N.; Sinha, S.K. (Ames Laboratory-ERDA and Department of Physics, Iowa State University, Ames, Iowa 50011). *Phys. Rev., B;* **16**: No. 9, 3919-3924(1 Nov 1977).

The electron-phonon spectral distribution function $\alpha^2(\omega)$ F (ω) has been calculated for niobium. The electron energy bands and wave functions were obtained from a self-consistent augmented-plane-wave muffin-tin potential, and the electron-phonon matrix elements were evaluated using the so-called rigid-ion approximation. With this approximation it is found that $\alpha^2(\omega)$ is constant over the whole energy spectrum. The electron-phonon mass enhancement has also been calculated for local regions of the Fermi surface and found to be anisotropic. The calculated local values of the enhancement do not agree with experimental values available for different orbits from de Haas—van Alphen measurements. The discrepancy seems to arise because the bare-rigid-ion matrix elements are relatively small between states with nearly pure l = 2 character.

26612 Small-angle critical neutron scattering from cobalt. Glinka, C.J.; Minkiewicz, V.J.; Passell, L. (University of Maryland, College Park, Maryland 20742). *Phys. Rev., B;* **16**: No. 9, 4084-4103(1 Nov 1977).

Total and inelastic-neutron-scattering measurements have been made of the small-angle critical scattering from polycrystalline cobalt both above and below its Curie temperature T/sub C/. Below T/sub C/ the scattering is dominated by well-defined spin-wave modes which exhibit quadratic dispersion, $h\omega(q) = Dq^2$. Within the hydrodynamic region, the spin-wave stiffness constant is found to have the power-law temperature dependence D proportional (T - T/sub C/)/sup x/ where x = 0.39 +- 0.05. As T/sub C/ is approached, the spin waves renormalize and broaden but no evidence of a central peak indicative of the longitudinal component of the susceptibility is observed. Above T/sub C/, the exponents γ = 1.23 +- 0.05 and ν = 0.65 +- 0.04, describing the power-law dependences of the static susceptibility and the inverse correlation range, respectively, have been obtained from the small-angle scans after taking full account of the inelasticity of the scattering. In addition, the critical scattering has been calibrated directly against the nuclear incoherent scattering and in this way the interaction range r_1, which appears in the classical and modified Ornstein-Zernike expressions for the asymptotic form of the spin pair correlation function, has also been determined. The linewidths of the quasielastic critical scattering have been measured over a range of wave vectors at temperatures up to 150 °C above T/sub C/. At T/sub C/ the linewidths vary with q to the 2.4 +- 0.2 power. Above T/sub C/, the linewidths are well described by a dynamical scaling function which, however, differs from that previously found for iron.

26613 Features of the expansion of condensed substances acted on by high-power shock waves. Rusakov, M.M.; Ivanov, R.I.; Shaidullin, B.K.; Shpak, S.G. *High Temp. (USSR) (Engl. Transl.);* **15**: No. 3, 381-386(Nov 1977).

Results are described of experiments studying the dispersion of various substances ranging from lithium hydride to tungsten after passage through them of high-power shock waves imparting an energy to the substances in the range of tens and hundreds of eV/atom. The dispersion took place in an expanding channel. The decay behavior of the velocity of the substance was determined and its temperature measured. The experiments showed that for expansion of the substances lying in a certain range of parameter variation, there is an increase in the thermal energy per unit amounting to as much as hundreds of eV/atom, the temperature rising as high as 7×10^4°K.

26614 Thermal conductivity of indium: mercury amalgams. Aivazov, A.A.; Smirnov, B.P.; Yurchak, R.P. (Moscow Institute of Electrical Engineering). *High Temp. (USSR) (Engl. Transl.);* **15**: No. 3, 434-438(Nov 1977).

The temperature: concentration dependence of the thermal and electrical conductivity of indium amalgams with indium content: 0, 5, 10, 20, 30, 40, 50 at.% is studied. The fact that there is a positive deviation from the Wiedemann: Franz law as the indium concentration is increased is established. The hypothesis is advanced that the existing anomalies are caused by peculiarities in the behavior of the electron state density function in the systems studied.

26615 Thermophysical properties of cubic carbides of zirconium and niobium at high temperatures. Korshunov, I.G.; Zinov'ev, V.E.; Gel'd, P.V.; Borukhovich, A.S.; Chernyaev, V.S.; Shveikin, G.P. (S. M. Kirov Ural Polytechnic Institute). *High Temp. (USSR) (Engl. Transl.);* **15**: No. 3, 439-444(Nov 1977).

The flat temperature wave method is used to measure the thermal diffusivity and heat capacity of cubic carbides of zirconium and niobium at high temperatures in the region of homogeneity. The energies of formation of equilibrium thermal vacancies are determined. The electrical resistance of the same samples was measured by the usual potentiometric method. Using the data obtained, the thermal conductivities of the samples and their electron components are calculated. The results obtained are discussed.

26616 Thermal and electrical conductivity of tantalum carbide at high temperatures (1500—3000°K). Danil'chenko, V.V.; Taubin, M.L.; Maskaev, A.S.; Deryavko, I.I. *High Temp. (USSR) (Engl. Transl.);* **15**: No. 3, 444-449(Nov 1977).

The temperature dependence of the thermal and electrical conductivity of tantalum carbide is experimentally determined in the interval 1500—3000°K. X-ray analysis carried out after high-temperature testing in vacuo showed that the free-carbon content in the surface layers had decreased. It is shown that free carbon present in the TaC matrix behaves in the thermal and electron transport process like a pore, which leads to a decrease in the thermal conductivity.

26617 Experimental study of the thermal expansion of various construction materials. Tantalum and tantalum—tungsten TV—10 alloy. Petukhov, V.A.; Chekhovskoi, V.Y.; Mozgovoi, A.G. (High-Temperature Institute, Academy of Sciences of the USSR). *High Temp. (USSR) (Engl. Transl.);* **15**: No. 3, 449-452(Nov 1977).

The optical comparator method is used to study the thermal expansion of tantalum of a vacuum TVCh brand melt and of a type TV—10 tantalum: tungsten alloy over a temperature range of 1146—2288°K. The experimental error with confidence probability 0.95 is equal to +- (0.5—0.9) %. The experimental error with confidence probability 0.95 is equal to +- (0.5—0.9) %. The experimental data are treated by the least-squares method, and approximate equations are obtained for the average temperature coefficient of linear expansion of the materials studied. A comparison is carried out with the data in the literature.

26618 Experimental investigation of thermal expansion of a number of construction materials, niobium, and niobium alloy 5VMTs1. Petukhov, V.A.; Chekhovskoi, V.Y.; Andrianova, V.G.; Mozgovoi, A.G. (High-Temperature Institute, Academy of Sciences of the USSR). *High Temp. (USSR) (Engl. Transl.);* **15**: No. 3, 561-563(Nov 1977).

A least-squares fit was used to compute the thermal expansion of Nb and alloy 5VMTs1 in the range 1261—2289°K.(AIP)

26619 Optical properties of metals at high temperatures. Shestakov, E.N.; Latyev, L.N.; Chekhovskoi, V.Y. (High-Temperature Institute, Academy of Sciences of the USSR). *High Temp. (USSR) (Engl. Transl.);* **15**: No. 2, 249-254(Sep 1977).

A method is described based on a study of the angular dependence of the emissivity for determining the optical constants of metals at high temperatures. Experimental values are presented for the optical properties of tungsten in the visible spectrum at high temperatures; a comparison is made with results of other authors.

26620 Speed of ultrasound and thermophysical properties of the liquid metals of Sn, Cd, Bi and their binary alloys Cd—Bi and Sn—Bi. Markov, B.G. (Volgograd Pedagogic Institute). *High Temp. (USSR) (Engl. Transl.);* **15**: No. 2, 255-258(Sep 1977).

The speed of sound in the liquid metals of Cd, Sn, and Bi and in the binary alloys Cd—Bi and Sn—Bi is measured over a wide range of temperatures. The speed of sound in bismuth and in most of the binary alloys decreases nonlinearly with heating. In the Cd—Bi system, the nonlinearity of the speed of sound as the temperature increases is associated with a rearrangement of the structure of bismuth. In the Sn—Bi system a similar nonlinearity is explained by the presence of chemical compounds in the melt. The concentration dependences of the computed quantities β/sub s/, β/sub T/, γ, c/sub v/ support this conclusion.

26621 Electrical resistance of niobium in the temperature range 200—2700°K. Peletskii, V.E. (High-Temperature Institute, Academy of Sciences of the USSR). *High Temp. (USSR) (Engl. Transl.);* **15**: No. 2, 262-267(Sep 1977).

Results of experimental investigations of the specific electrical resistance of niobium are analyzed. An equation is proposed which describes the temperature dependence of the resistance over an extended temperature range. The coefficients of the equation are found by the least-squares method. A confidence interval is given for the recommended values.

26622 Integral hemispherical degree of blackness of alloys of high-melting metals at high temperatures. Vertogradskii, V.A. (High-Temperature Institute for Aviation Materials). *High Temp. (USSR) (Engl. Transl.);* **15**: No. 2, 363-365(Sep 1977).

The blackness was determined for the metals W, Mo, and Re and for the alloys VR-5, VR-10, VR-20, VR-27, MR-50, and MV-50. The temperature range covered was 1200—3000°K.(AIP)

26623 Temperature dependence of the thermal conductivity and electrical conductivity of sintered molybdenum in the low-temperature region. Pozdnyak, N.Z.; Serykh, G.M.; Ivanov, V.A. (All-Union Correspondence Polytechnic Institute). *High Temp. (USSR) (Engl. Transl.);* **15**: No. 2, 365-367(Sep 1977).

The thermal and electric conductivity of sintered Mo was measured for the temperature range 50-400°C. The temperatures of the furnace and the sample were determined using a system of calibrated thermocouples.

26624 Oscillations of properties of thin superconducting films with varying coating thickness. Osipov, K.A.; Orlov, A.F.; Dmitriev, V.P.; Milai, A.K. (A. A. Baikov Institute of Metallurgy, Academy of Sciences of the USSR, Moscow). *Sov. Phys. - Solid State (Engl. Transl.);* **19**: No. 8, 1304-1306(Aug 1977).

Superconducting film systems with two and three layers were formed by successive condensation in ultrahigh vacuum on Polikor backings cooled to liquid helium temperatures. The superconducting layers were thin (30—100 A) films of lead, gallium, molybdenum, and rhenium; the coating materials were semiconductors (carbon, selenium, silicon, germanium), semimetals (bismuth), and metals (silver, zinc, aluminum, titanium, gallium, lead, molybdenum). The temperature T/sub c/ of the superconducting transition and the residual resistance R/sub N/ were studied as functions of the coating thickness. It was found that the variation of T/sub c/ and R/sub N/ with increasing coating thickness may be oscillatory or monotonic, depending on the combination of materials condensed. The oscillation period is of the order of 10 A and the oscillation amplitude at the first extremum is inversely proportional to the superconducting film thickness. An important point is that coating films of different superconductors with the same material may have qualitatively different effects on the nature of the dependences studied. For example, lead and gallium films coated with germanium show an oscillatory function T/sub c/(d/sub Ge/), with respectively an initial rise or fall of T/sub c/, but for molybdenum films T/sub c/(d/sub Ge/) is monotonic.

26625 Scattering of conduction electrons by spin disorder in rare-earth dysprosium—yttrium alloys. Nikitin, S.A.; Nakvi, S.M.; Solomkin, I.K.; Chistyakov, O.D. (M. V. Lomonosov State University, Moscow). *Sov. Phys. - Solid State (Engl. Transl.);* **19**: No. 8, 1347-1351(Aug 1977).

An investigation was made of the electrical properties of single crystals of Dy—Y alloys. The magnon contribution to the electrical resistivity was found to be anisotropic and it varied linearly with the yttrium concentration in the basal plane but nonlinearly along the hexagonal axis. A strong scattering of the conduction electrons due to the magnetic disorder was observed at low temperatures. The indirect exchange theory and the experimental results were used in a calculation of the s—f exchange interaction integral and of the conductivity effective electron mass, and in a determination of the dependences of these quantities on the atomic volume.

26626 Thermomodulation spectra of the superconducting alloy $Nb_3(AlSi)$. Golovashkin, A.I.; Dzhuraev, D.R.; Levchenko, I.S.; Motulevich, G.P.; Shelekhov, A.I. (P. N. Lebedev Physics Institute, Academy of Sciences of the USSR, Moscow). *Sov. Phys. - Solid State (Engl. Transl.);* **19**: No. 8, 1420-1423(Aug 1977).

Thermomodulation spectra of films of the superconducting alloy Nb_3 (AlSi) were determined in the range 1.1—2.8 eV. Two overlapping absorption bands were observed, and these were identified with interband transitions near the Bragg planes {200} and {210}. The change in the reflection coefficient had a maximum value of (2—3) x 10^{-4} deg^{-1}. The Fourier components of the pseudopotential $V_{200} \simeq 1.0$ eV and $V_{210} = 0.88$ eV were determined, together with the collision frequencies of the electrons taking part in the interband transitions.

CORROSION AND EROSION

REFER ALSO TO CITATION(S) 25621, 25626, 25628, 25629, 25643, 25647, 25936, 25962, 26274

RADIATION EFFECTS

REFER ALSO TO CITATION(S) 26292, 26301, 26302, 26303, 26306, 26309, 26310, 26311, 26316, 26317, 26430

26627 Direct observation of self-interstitial-type defects in metals through combined single-double alignment channeling backscattering. Pronko, P.P. (Materials Science Division, Argonne National Laboratory, Argonne, Illinois 60439). *Phys. Rev., B;* **16**: No. 11, 4753-4755(1 Dec 1977).

Combined single-double alignment channeling backscattering is used to extract information concerning self-interstitial-type defect in radiation-damaged gold. The method eliminates difficulties associated with channeling backscattering as a probe for studying such defect at concentration levels between 0.1 and 1 at.% by experimentally separating the dechanneled component of the beam from the directly scattered fraction. The interstitial-type defects observed at room temperature in self-ion irradiated gold are thought to be the cores of clustered point defects.

26628 Radiation-annealing effects in energetic displacement cascades. Averback, R.S.; Merkle, K.L. (Materials Science Division, Argonne National Laboratory, Argonne, Illinois 60439). *Phys. Rev., B;* **16**: No. 9, 3860-3869(1 Nov 1977).

Radiation-annealing effects due to energetic displacement cascades have been studied in copper, silver, and gold using electrical-resistivity measurements of thin-film specimens. It was found that close Frenkel pairs are unstable in the region of an energetic cascade. This was shown by doping the specimens with Frenkel pairs using a 150-keV proton irradiation at low temperature and measuring the damage rate during a subsequent heavy-ion irradiation. For ~ 500-keV self-ion irradiations the volume around the cascade in which close Frenkel pairs are unstable is 5 x 10^{-16}, 2 x 10^{-16}, and 4 x 10^{-17} cm^3 for silver, gold, and copper, respectively. Moreover, it was observed that the volume increased with increased energy density in the cascade. The implications of these results on defect production, defect saturation behavior, and isochronal recovery for damage produced in energetic cascades are discussed.

CERAMICS, CERMETS, AND REFRACTORIES

REFER ALSO TO CITATION(S) 26578

PREPARATION AND FABRICATION

REFER ALSO TO CITATION(S) 26072, 26305

26629 (ORNL/TM—5895) **Impact of alternate fuels on refractories and refractory insulations.** (Oak Ridge National Lab., Tenn. (USA)). May 1977. Contract W-7405-ENG-26. 67p. (CONF-7609156—). Dep. NTIS, PC A03/MF A01.

From Seminar on the impact of alternate fuels on refractories and refractory insulations; Washington, DC, USA (21 Sep 1976).

Topics covered in the seminar include: assessment of the impact of alternate fuels on refractories and refractory insulations; alternate fuel experience in refractory manufacturing; slagging of refractories by ash from alternate fuels; and substitution of coal for natural gas in face brick production. A panel discussion following the formal presentations is summarized. (GHT)

STRUCTURE AND PHASE STUDIES

26630 Search criterion for lattice internal rearrangement modes: Correlation between lattice structural and magnetic structural transitions. Cooper, B.R. (Department of Physics, West Virginia University, Morgantown, West Virginia 26506). *Phys. Rev., B;* **17**: No. 1, 293-296(1 Jan 1978).

The occurrence of lattice internal rearrangements is of great interest because of the association through strong magnetoelastic interaction with first-order magnetic transitions, where the magnetic structure is likely to be unusual and highly anisotropic. We consider the physical basis for such modes occurring. The predictions for the NaCl and fluorite structures are quite restrictive on wave vector and polarization; and for the NaCl structure are highly evocative of a correlation between a lattice structural transition involving the predicted internal rearrangement mode and the magnetic transition to the IA magnetic structure.

26631 Electron-nuclear double resonance of V/sub OD/ defects in SrO. Boldu O., J.L.; Stapleton, H.J.; Chen, Y.; Abraham, M.M. (Solid State Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830). *Phys. Rev., B;* **16**: No. 9, 3875-3879(1 Nov 1977).

Single crystals of SrO doped with deuterium were grown by the submerged-arc fusion technique. The V/sub OD/ center was produced by γ irradiation at 77 K and its identity confirmed by EPR and electron-nuclear double-resonance measurements. The defect possesses < 100 > axial symmetry and can be described with the spin-Hamiltonian parameters: g/sub parallel()/g/sub perpendicular()/A/sub parallel()/MHz, A/sub perpendicular()/MHz, and P = +0.158(1) MHz. Absolute signs are based on the assumption that the reported positive deuterium nuclear moment requires the anisotropic portion of the hyperfine interaction to be positive. From the hyperfine parameters, a value of 5.078 A for the OD^- - (Sr vacancy) -O^- distance in this linear defect can be computed. Since the normal oxygen spacing in SrO is 5.16 A, this implies an inward relaxation of the oxygens that is contrary to the previously observed cases of V/sub OH/ and V/sub OD/ defects in the alkaline-earth oxides where outward distortions occur.

MECHANICAL PROPERTIES

REFER ALSO TO CITATION(S) 25630, 26144, 26443, 26599

26632 (SAND—782076C) **HPBN development.** Irwin, J.L. (Sandia Labs., Albuquerque, N.Mex. (USA)). 1978. Contract EY-76-C-04-0789. 22p. (CONF-780220—1). Dep. NTIS, PC A02/MF A01.

From Advances in reentry thermal protection technology; Los Angeles, CA, USA (15 Feb 1978).

Introductory remarks on the physical and mechanical properties of hot-pressed boron nitride (HPBN) were given first. Types of

HPBN include HD 0092 (HBC), TS1251, and modified HPBN (SS3500, SS3900). The object of the work was to improve properties affecting thermal stresses and not affect dielectric and ablation characteristics. Experimental procedures were listed. Figures and tables showed the following for TS1251 and SS3500: ultrasonic modulus of HPBN vs temperature, average ultimate tensile strength vs temperature (perpendicular and parallel to pressing), stress—strain comparisons, comparisons of compressive strength vs temperature (perpendicular and parallel to pressing), thermal expansion of HPBN (parallel and perpendicular to pressing), thermal conductivity of HPBN, average dielectric properties of HPBN, ablation test data for HPBN, material models for HPBN, typical flight thermal stress comparison. It was concluded that materials with limited metallic inclusions are preferred, modifying present HPBN improves properties considerably without affecting ablation and dielectric properties, thermal stress factors for SS3500 are considerably improved over TS1251, and thermal stress analyses indicate that the SS3900 HPBN could improve the thermal stress ratio over SS3500. This report appears to be a set of slides or similar material for a talk, and contains no text as such. (RWR)

26633 Thermophysical properties of liquid uranium carbide. Finn, P.A.; Sheth, A.; Winslow, G.; Leibowitz, L. (Argonne National Lab., IL). pp 189-204 of Advanced LMFBR fuels. Leary, J.; Kittle, H. (eds.). La Grange Park, IL; American Nuclear Society (1977).

From International meeting on advanced LMFBR fuels; Tucson, AZ, USA (10 Oct 1977).

See CONF-771008—.

Uranium-plutonium carbide, which has better neutronic properties and higher thermal conductivity than uranium-plutonium oxide, has been considered as a fuel for nuclear reactors. In order to perform essential reactor safety analyses, many thermodynamic and transport properties at temperatures exceeding 6000 K are needed. The required values include vapor pressure, density, volume expansion, heat capacity, enthalpy, compressibility, and viscosity. It was necessary to develop a self-consistent method that could be used to extrapolate known property values to the liquid region. This report summarizes work on uranium carbide.

26634 Fuel properties of advanced fuels (U,Pu)CN important for out-of-pile and in-pile kinetics. Matzke, H.; Ronchi, C. (Joint Research Centre, Karlsruhe, Ger.). pp 218-244 of Advanced LMFBR fuels. Leary, J.; Kittle, H. (eds.). La Grange Park, IL; American Nuclear Society (1977).

From International meeting on advanced LMFBR fuels; Tucson, AZ, USA (10 Oct 1977).

See CONF-771008—.

The investigated fuels covered the whole range of (U,Pu)C over (U,Pu)C/sub x/N/sub 1-x/ to (U,Pu)N, and some additional work was devoted to oxycarbides (U,Pu)CO. The properties studied are described and include self-diffusion, sintering and densification, mechanical properties like plasticity and crack formation, thermal conductivity, pore mobility and fuel restructuring in an applied thermal gradient simulating expected in-pile thermal gradients, and solubility of fission products.

26635 Creep behavior of mixed-carbide advanced nuclear fuel. Singh, R.N. (Argonne National Lab., IL). pp 257-266 of Advanced LMFBR fuels. Leary, J.; Kittle, H. (eds.). La Grange Park, IL; American Nuclear Society (1977).

From International meeting on advanced LMFBR fuels; Tucson, AZ, USA (10 Oct 1977).

See CONF-771008—.

Primary and steady-state creep behavior of $(U_{0.8}PuO_{0.2})C_{1.0}$ advanced nuclear fuel was investigated as functions of stress (6.89 to 68.9 MNm^{-2}) and temperature (1573 to 1873 K). Mixed carbide fuel exhibits higher primary and steady-state creep rates when compared with stoichiometric mixed-oxide fuel of the same density, grain size, and Pu concentration for identical testing conditions.

PHYSICAL PROPERTIES

REFER ALSO TO CITATION(S) 26632

26636 (AD-A—042144) Infrared emissivities of micron-sized particles of C, MgO, Al_2O_3, and ZrO_2. Final report. Dowling, J.M.; Randall, C.M. (Aerospace Corp., El Segundo, Calif. (USA). Chemistry and Physics Lab.). 30 Apr 1977. Contract F04701-76-C-0077. 226p. NTIS PC A11/MF A01.

The Particle Optical Properties Measurements (POPM) Program is designed to assess the reliability of computing the infrared emissivity of hot particles from refractive index values measured on bulk samples. An experimental apparatus to observe the thermal radiation from a single particle electrostatically levitated and heated by 1.06 micrometer Nd:YAG laser radiation has been constructed and has demonstrated the capability of simultaneously levitating and irradiating single micron sized particles.

26637 Sublattice magnetization in TbD_2: crystalline electric field effects. Shaked, H.; Faber, J. Jr. (Argonne National Laboratory, Argonne, Illinois 60439). *Phys. Rev., B;* **16**: No. 11, 4982-4985(1 Dec 1977).

The temperature dependence of the sublattice magnetization in TbD_2 has been measured by neutron diffraction. A sharp increase in sublattice magnetization is observed at T/sub N/. Calculations that take into account the combined effects of the molecular field and crystalline electric field have been performed. These calculations show that the sharp increase in sublattice magnetization is due to a first-order phase transition at T/sub N/, which accounts for ~0.3 of the saturated sublattice magnetization.

26638 Single-particle properties of systems undergoing structural phase transitions. Bruce, A.D.; Schneider, T. (Department of Physics, The University of Edinburgh, Edinburgh, Scotland, United Kingdom). *Phys. Rev., B;* **16**: No. 9, 3991-3999(1 Nov 1977).

We study the properties of the single-particle probability density function for a d-dimensional model system exhibiting a structural phase transition. Using renormalization-group methods (in d = 1) and exact inequalities (in d = 3) we examine, in particular, the extent to which the behavior of this function can reveal the distinctive changeover in dynamical behavior expected for a system exhibiting a displacive phase transition.

26639 Specific electrical conductivity of liquid yttrium oxide at high temperatures. Shpil'rain, E.E.; Kagan, D.N.; Barkhatov, L.S.; Zhmakin, L.I. (High-Temperature Institute, Academy of Sciences of the USSR). *High Temp. (USSR) (Engl. Transl.);* **15**: No. 2, 359-360(Sep 1977).

The electric conductivity of liquid Y_2O_3 was measured from its melting point to 3200°K in an argon atmosphere. An equation relating the specific electric conductivity to temperature is presented.(AIP)

26640 Characteristics of the excitation of Al_2O_3—Eu and Y_2O_3—Eu surface luminescence centers. Dmitrenko, Z.F.; Mikho, V.V. *Opt. Spectrosc. (USSR) (Engl. Transl.);* **43**: No. 2, 216-217(Aug 1977).

The partial ionization of luminescence centers due to interactions with H^+ ions from photodissociated water vapor molecules was studied for Al_2O_3—Eu and Y_2O_3—Eu. The exciting radiation was of wavelength 366-nm. (AIP)

RADIATION EFFECTS

REFER ALSO TO CITATION(S) 26282, 26292, 26293, 26299, 26300, 26301, 26302, 26303, 26305, 26306, 26307, 26308, 26309, 26310, 26311, 26316, 26317, 26318, 26319, 26320

26641 Chemical state of irradiated carbide fuel pins. Kleykamp, H. (Kernforschungszentrum, Karlsruhe, Ger.). pp 166-178 of Advanced LMFBR fuels. Leary, J.; Kittle, H. (eds.). La Grange Park, IL; American Nuclear Society (1977).

From International meeting on advanced LMFBR fuels; Tucson, AZ, USA (10 Oct 1977).

See CONF-771008—.

The postirradiation studies of uranium-plutonium carbide fuel pins for the development of a fuel element for operation in the German SNR-300 reactor have enabled characterisation of the chemical state of carbide fuels. The latter is influenced by the compositional changes during irradiation resulting from the fission process and by redistribution of the fuel components and the fission products. These effects have been investigated by metallographic techniques, electronprobe microanalysis, and scanning electron microscopy on fuel pins that had been irradiated in the thermal reactors FR2 and BR2 and in the Dounreay Fast Reactor DFR. The current status of knowledge based on these irradiation experiments is reviewed.

COMPOSITE MATERIALS

PHYSICAL PROPERTIES

26642 Thermal conductivity of refractory materials in a wide range of temperatures and rarefunctions of a gaseous medium. Litovskii, E.Y.; Landa, Y.A.; Zborovskii, I.D. (All-Union Institute of Refractories). *High Temp. (USSR) (Engl. Transl.);* **15**: No. 3, 511-516(Nov 1977).

This article gives investigated and correlated data on the dependence of the coefficient of thermal conductivity on the pressure of the gas and the temperature for 19 brands of dense and lightweight refractories. Effects of a double change in the monotonicity were observed, as well as hysteresis of the temperature dependence of the coefficient of thermal and conductivity with rarefaction of the gas medium.

DEGRADATION AND EROSION

REFER ALSO TO CITATION(S) 25787

OTHER MATERIALS

PREPARATION AND MANUFACTURE

REFER ALSO TO CITATION(S) 25988, 25996, 26542

STRUCTURE AND PHASE STUDIES

26643 Pressure dependence of the lattice parameters of anthracene up to 5.4 kbar and a re-evaluation of the elastic constants. Elnahwy, S.; El Hamamsy, M.; Damask, A.C.; Cox, D.E.; Daniels, W.B. (Queens College of the City University of New York, Flushing, New York 11367). *J. Chem. Phys.;* **68**: No. 3, 1161-1163(1 Feb 1978).

The lattice parameters of an anthracene crystal were measured as functions of hydrostatic pressure in the pressure range from 0—5.4 kbar using neutron diffraction techniques. The results were found to agree with previous measurements of the volume compressibility of anthracene and, in the a and b directions, with the values extrapolated from linear compressibility data for linear polyphenyls. The values of the linear compressibilities were used to derive an improved set of elastic constants from currently available velocity of sound data.

26644 Structural disorder and electronic properties of amorphous silicon. Ching, W.Y.; Lin, C.C.; Guttman, L. (Department of Physics, University of Wisconsin, Madison, Wisconsin 53706). *Phys. Rev., B;* **16**: No. 12, 5488-5498(15 Dec 1977).

We have performed a first-principles calculation of the electronic energies for amorphous Si using the method of orthogonalized linear combinations of atomic orbitals. The basis functions are the 3s, 3p Bloch sums for each atom in the large quasi-unit-cell orthogonalized to all 1s, 2s, 2p Bloch sums. All the multicenter integrals and Hamiltonian matrix elements are computed exactly by the Gaussian technique with no empirical parametrization. Applied to a recently constructed periodic random-network structural model, the method yields a band gap of 0.67 eV. An alternative scheme is to employ as basis functions orthogonalized 3s, 3p orbitals centered at sites within a cluster to obtain energy levels and to configurationally average the results over several clusters. This scheme is applied to make similar analyses for the nonperiodic networks of Polk and Boudreaux (as refined by Steinhardt, Alben, and Weaire) and of Connell and Temkin; the calculated band gaps are 2.19 and 1.24 eV, respectively. The general profiles of the density of states for different nets show relatively little variation, but the band gap depends quite sensitively on the details of the structural disorder.

PROPERTIES

REFER ALSO TO CITATION(S) 26636

26645 (AD-A—043340) **Optical and zero field magnetic resonance spectroscopy of inorganic molecular solids. Final report, 1 June 1975—31 May 1977.** Bernstein, E.R. (Colorado State Univ., Fort Collins (USA). Dept. of Chemistry). Jul 1977. 8p. NTIS PC A02/MF A01.

Optical and magnetic resonance investigations of inorganic molecular solids were performed. Optical, Raman, and zero field magnetic resonance are studied for XF_6 (X = U, Mo, W, Re, Ir) and $M(BH_4)_4$ (M = Zr, Hf, U) in order to learn about energy transfer, relaxation, and molecular solid state dynamics.

26646 Strain-confined electron-hole liquid in germanium. Jeffries, C.D.; Wolfe, J.P.; Markiewicz, R.S. (Univ. of California, Berkeley). pp 879-888 of Physics of semiconductors. Fumi, F.G. (ed.). New York; Elsevier/North-Holland Inc. (1976).

From 13. international conference on physics of semiconductors; Rome, Italy (30 Aug 1976).

See CONF-760860—.

A suitable stress applied to a Ge crystal creates a point of minimum energy for electron-hole drops within the crystal. Due to the anisotropy of Ge one or more such potential wells can be formed, into which the electron-hole liquid collects--producing a roughly spherical volume of liquid of size r = 0.3 mm and e-h density = 0.7 x $10^{17}cm^{-3}$. Photographs of these large drops have been recorded by imaging the recombination luminescence; the data are in agreement with a numerical calculation of the stress tensor, band edge shift, and drop energy as a function of position in the inhomogeneously stressed crystal. Using time-resolved slit-scanned luminescence spectroscopy, we have studied the spatial and temporal distribution of the liquid following pulsed excitation. Due to the lowered density in the large drop, the lifetime is 10x longer than for droplets in unstressed Ge. The build-up and decay of a large drop have been studied by microwave absorption: a sharp resonance occurs in a few kilogauss when the Alfven wavelength matches the drop dimension. The microwave, luminescence and photographic studies consistently support the model of a large strain-confined electron-hole drop in Ge.

26647 (UCRL—76010) **Approximate method for determining the influence of water and porosity on the Gruneisen gamma.** Kurtz, S.R. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 16 Jan 1975. Contract W-7405-ENG-48. 11p. Dep. NTIS, PC A02/MF A01.

An expression showing the dependence of the zero pressure Gruneisen gamma ($GAMMA_0$) for solids on the water content (W) and total porosity (phi) of the material under consideration has been developed. It has been assumed in this treatment that the effects of the water can be treated separately from those of the solid material. Then $GAMMA_0$ for the composite material is simply a linear combination of the individual Gruneisen gammas for the water (GAMMA/sub 0W/) and dry, porous material (GAMMA/sub 0S/), with the terms weighted according to the amount of water present, i.e., $GAMMA_0$ = WGAMMA/sub 0W/ + (1 - W)GAMMA/sub 0S/. Values of GAMMA/sub 0S/ are found by using a technique where the Gruneisen gamma for dry, porous material is proportional to $(1 - phi)^5$ times that for solid material. Using the derived expression for $GAMMA_0$ the effects of varying W and phi were studied. For constant W, $GAMMA_0$ decreases with increasing phi. However, for constant phi, the effect of varying W depends upon the value of phi.

26648 Infrared-to-visible conversion in (Y, Yb, Er)F_3 and (Y, Yb, Ho)F_3. Ettinger, D.G.; Niemczyk, T.M. (Department of Chemistry, The University of New Mexico, Albuquerque, New Mexico 87131). *J. Chem. Phys.;* **68**: No. 3, 872-879(1 Feb 1978).

Visible emission spectra from (Y/sub 0.80/Yb/sub 0.19/Er/sub 0.01/)F_3 and (Y/sub 0.80/Yb/sub 0.19/Ho/sub 0.01/)F_3 were obtained upon excitation at 970 nm. Emission bands at 656, 548, 520, 409, and 380 nm are observed in the Er^{3+} phosphor, and at 746, 645, 544, and 489 nm in the Ho^{3+} phosphor. The origin of each of these bands is discussed. Data presented for the 656 nm emission in the Er^{3+} phosphor show that it can be the result of only one of three previously proposed mechanisms. The 746 nm band from the Ho^{3+} system has not been previously discussed in the literature even though it is the most intense emission band. Data presented for the temperature dependence of the upconversion process in these two phosphors show that generalizatons made about the mechanism of energy transfer in the Ho^{3+} system based on the more widely studied Er^{3+} system are not valid.

26649 Heat capacity, entropy, and Gibbs energy of technetium hexafluoride between 2.23 and 350 K; magnetic anomaly at 3.12 K; mean β energy of ^{99}Tc. Osborne, D.W.; Schreiner, F.; Otto, K.; Malm, J.G.; Selig, H. (Chemistry Division, Argonne National Laboratory, Argonne, Illinois 60439). *J. Chem. Phys.;* **68**: No. 3, 1108-1118(1 Feb 1978).

The heat capacity of solid and liquid technetium hexafluoride has been measured between 2.3 and 350 K. The standard entropy, S^0, the enthalpy increment, $(H^0-H^0_0)$, and the Gibbs energy function, $(G^0-H^0_0)/T$, have been calculated. At T=298.15 K, the thermodynamic functions have the following values: C^0/sub p/=157.84 J $K^{-1}xmol^{-1}$, S^0=253.52 +- 0.25 J $K^{-1}xmol^{-1}$, $(H^0-H^0_0)$ =38331 +- 38 J mol^{-1}, and $(G^0-H^0_0)/T$=-124.95 +- 0.12 J $K^{-1}xmol^{-1}$. TcF_6 has a solid—solid transition at 268.335 K associated with an enthalpy change ΔH^0/sub tr/=8024.9 +- 5.0 J mol^{-1}. It melts at 311.14 +- 0.05 K and has an enthalpy of fusion of ΔH^0/sub f/=4618.86 +- 1.60 J mol^{-1}. TcF_6 has a lambda-shaped anomaly in the heat capacity with a peak at 3.12 K, probably caused by a transition to a ferromagnetic state. A similar lambda-shaped transition was observed for rhenium hexafluoride at 1.30 +- 0.05 K. The magnetic entropy of TcF_6 is estimated to be 5.823 J $K^{-1}xmol^{-1}$. The third law value for the standard entropy of TcF_6 vapor at 320 K was calculated to be S^0 (TcF_6, g) =371.278 +- 0.750 J $K^{-1}xmol^{-1}$. Molecular data for TcF_6 lead to a lower value of S^0 (TcF_6, g, 320 K) = 367.53 J $K^{-1}xmol^{-1}$. The entropy from molecular data can be made to agree with the calorimetric value if the frequency for the inactive vibrational mode ν_6 is lowered to 131 cm^{-1} from the reported value of 145 cm^{-1}. The average energy of the β decay of ^{99}Tc was evaluated from the radioactive self-heating of the sample and was found to be 97.2 +- 1.2 keV. This number exceeds the literature value but agrees with a more recent integration of the β spectrum.

26650 Re-examination of the inelastic neutron scattering in tetrathiafulvalene-tetracyanoquinodimethane (TTF-TCNQ). Mook, H.A.; Shirane, G.; Shapiro, S.M. (Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830). *Phys. Rev., B;* **16**: No. 12, 5233-5237(15 Dec 1977).

Neutron-inelastic-scattering measurements have been repeated on deuterated and protonated TTF-TCNQ samples at BNL (Brookhaven National Laboratory) and ORNL (Oak Ridge National Laboratory) in order to clarify the phonon scattering and the scatter-

ing found at q = 2k/sub F/. Good agreement is found between the phonon measurements made in the two laboratories on both samples. Differences in the slope of the transverse-acoustic phonon originally reported between the two laboratories can most likely be ascribed to the wider mosaic spread of the ORNL sample. Measurements at q = 2k/sub F/ at room temperature are presented and no distinct anomaly is observed for an energy transfer of 3.3 meV. From this we can estimate that any scattering at 2k/sub F/ at room temperature must be smaller than ~8% of the longitudinal-acoustic (LA) phonon intensity for 2.9 meV. On this basis, the earlier published results showing a giant room-temperature Kohn anomaly originating from the LA branch would have to be reconsidered.

26651 Theory of valence-band Auger spectra: GaAs(110). Feibelman, P.J.; McGuire, E.J.; Pandey, K.C. (Sandia Laboratories, Albuquerque, New Mexico 87115). *Phys. Rev., B;* **16**: No. 12, 5499-5505(15 Dec 1977).

In order to establish the utility of Auger line-shape analysis as a probe of local electronic structure at surfaces, we propose the study of GaAs(110) 1 x 1. This surface is of interest because extensive theoretical studies of GaAs band structure, both bulk and surface, are available, because the 1 x 1 nature of this surface's "reconstruction" permits a relatively unambiguous determination of its atomic geometry, and because the local densities of states (LDOS's) on the Ga and As atoms are very different. We calculate the Ga and As M_1M/sub 4,5/V and M/sub 2,3/M/sub 4,5/V Auger line shapes for GaAs(110) and show that they differ considerably from one another, reflecting the differing angular-momentum compositions of the Ga and As LDOS's and the facts that valence s-electron emission is favored in the M_1M/sub 4,5/V case while s- and p-electron emission are roughly equally weighted in the M/sub 2,3/M/sub 4,5/V lines.

26652 Neutron-diffraction study of the staggered magnetization of $CuCl_2$ x $2D_2O$. Lynn, J.W.; Heller, P.; Lurie, N.A. (Department of Physics, Brookhaven National Laboratory, Upton, New York 11973). *Phys. Rev., B;* **16**: No. 11, 5032-5039(1 Dec 1977).

The neutron-scattering technique has been used to measure the staggered magnetization of the S = 1/2, d = 3 antiferromagnet $CuCl_2$ x $2D_2O$ as a function of temperature and magnetic field. The critical exponents β/sub perpendicular/, β/sub parallel/ describing the temperature variation of the order parameter in the regions well above and well below the bicritical point, respectively, were found to be β/sub perpendicular/ = 0.321 +- 0.01 and β/sub parallel/ = 0.324 +- 0.013. These values are within experimental error of the theoretically expected value of 0.325 for the d = 3 Ising model. At the spin-flop transition the staggered magnetization changed 8% in magnitude, the reduction being due to the anisotropy of the g factor. The magnetic form factor in the spin-flop region was found to be the same as that previously determined in zero field. In addition, with the applied field tilted in the a-b plane away from the a axis, the direction of the staggered magnetization was found to rotate continuously from the a to the b direction as is expected theoretically. The observed range in field over which the rotation takes place, however, is narrower than the predictions of mean-field theory.

26653 Breakdown of the "white noise approximation" in the Moessbauer relaxation spectra: The case of $Cs_2NaYbCl_6$. Dattagupta, S.; Shenoy, G.K.; Dunlap, B.D.; Asch, L. (Reactor Research Center, Kalpakkam 603102, India). *Phys. Rev., B;* **16**: No. 9, 3893-3902(1 Nov 1977).

There are many restrictions on using the white-noise approximation to describe the line shape of radiation emitted by a Moessbauer atom experiencing paramagnetic relaxation. Using a resolvent operator method we have obtained an expression for the line shape without making such an approximation. As a result the relaxation matrix depends on the hyperfine frequencies as well as on correlation functions of the bath variables. The situation has been illustrated for the case of spin-spin relaxation of a "rigid lattice" using an exponential form for the correlation function. The calculations have been utilized to analyze the Moessbauer relaxation spectra of $Cs_2NaYbCl_6$ measured using the 84.6-keV transition in ^{170}Yb. The analysis permits us to deduce the dipolar field and the correlation time for the spin bath in this material.

26654 Superconducting- and normal-state thermal conductivity of $NbSe_2$. Roeske, F. Jr.; Shanks, H.R.; Finnemore, D.K. (Ames Laboratory—ERDA and Department of Physics, Iowa State University, Ames, Iowa 50011). *Phys. Rev., B;* **16**: No. 9, 3929-3935(1 Nov 1977).

Thermal-conductivity measurements have been used to study the temperature dependence of the scattering of phonons and electrons in single crystals of the superconducting layer compound $NbSe_2$ between 1 and 10 K. In this temperature range, the results agree with standard theoretical models for a three-dimensional metal. The magnetoresistance has a very strong linear magnetic-field dependence as might be expected if there were magnetic breakdown at superzone gaps induced by charge-density waves.

26655 Investigation of the heat capacity and of the superconducting properties of the sulfide Mo_6NaS_8. Alekseevskii, N.E.; Wolf, G.; Dobrovol'skii, N.M.; Thiele, U. (Institute of Physics Problems, USSR Academy of Sciences). *JETP Lett. (USSR) (Engl. Transl.);* **25**: No. 12, 523-525(20 Jun 1977).

The heat capacity and the temperature dependence of the critical field of the superconducting molybdenum sulfide Mo_6NaS_8 was measured. It is shown that, in contrast to Mo_6SnS_8, the value of C/sub p//T above the critical temperature deviates little from a linear function of T^2. We determined the Debye temperature θ/sub D/=118 K, the Sommerfeld constant γ=9.2 x 10^{-3} J/K^2 mole, the derivative (dH/sub c//dT)/sub T T/c-italic=12.8kOe/K and the critical field H/sub c/(0) =100 kOe.

CORROSION, EROSION, AND DEGRADATION

26656 (NTIS/PS—77/0966) **Corrosion of reinforced concrete (citations from the NTIS data base). Report for 1964-Nov 77.** Smith, M.F. (National Technical Information Service, Springfield, Va. (USA)). Nov 1977. 158p. NTIS PC N01/MF N01.

Studies from Federally funded research reports on attack of concrete and its reinforcement in bridge decks, underwater and offshore structures, structural beams, buildings, and nuclear reactor equipment are cited. Degradation caused by chlorides, deicers, marine atmospheres, and sea water are covered in the majority of the abstracts. Prevention and inhibition of corrosion by coatings, membranes, additives, impregnation by oils and polymers, and sealing are also described. (Contains 153 abstracts)

26657 Raman scattering from hybridized electronic levels in uniaxially stressed Ge(As). Gorman, M.; Solin, S.A. (Univ. of Chicago). pp 243-246 of Physics of semiconductors. Fumi, F.G. (ed.). New York; Elsevier/North-Holland Inc. (1976).

From 13. international conference on physics of semiconductors; Rome, Italy (30 Aug 1976).

See CONF-760860—.

The stress dependence of the valley-orbit electronic Raman transition of Ge(As) has been determined for uniaxial stress along [111] and [110]. Raman shifts associated with $1s(A_1) \rightarrow 1s(GAMMA/sub\ i/)$ GAMMA not equal to A_1 transitions can be accurately calculated from the theory of Price. In contrast transitions terminating on $1s(A_1)$ levels deviated significantly from the theory. The deviation is attributed to stress-induced hybridization between the 1s and 2s levels.

RADIATION EFFECTS

REFER ALSO TO CITATION(S) 27398

26658 (AD-A—042226) **Absorption of electromagnetic radiation in the transparent regime of solids. Final report, 14 October 1974—13 October 1975.** Mitra, S.S. (OES, Inc., Long Beach, Calif. (USA)). Mar 1977. 12p. (URI—9804/4528). NTIS PC A02/MF A01.

Interaction of high power laser radiation with matter has been considered. In particular, one- and multiphoton absorption coefficients in direct gap semiconductors have been calculated using a number of theoretical models and compared with experimental data. Selective multiple photon absorption by an anharmonic molecule has been treated including the effects of the rotational sublevels and the Stark broadening of the energy levels. The applicability has been examined of the extended avalanche breakdown process to describe window surface damage by pulsed CO_2 lasers. A low-loss isolator for 5.26 micrometer radiation utilizing the Zeaman effect in gases has been proposed.

26659 (AD-A—042429) **Effects of fast and thermal neutron flux and gamma radiation on the transmission characteristics of optical fibers. Interim report.** Sieber, D.C.; McCormack, R.G.; Croisant, W.J. (Army Construction Engineering Research Lab., Champaign, Ill. (USA)). Jul 1977. 23p. (CERL-IR-E—112). NTIS PC A02/MF A01.

This report presents the results of a study of the effects of nuclear radiation on the light transmission characteristics of optical fibers. Two types of radiation were used: 1800-MW pulses of primarily thermal neutrons (10 to the 12th power n/sq.cm.), and a 20-minute exposure of thermal and fast neutrons and gamma radiation. Three representative types of optical fibers were tested: low-loss fused silica, medium-loss lead silicate with borosilicate cladding, and plastic. The fibers' radiation-induced attenuation changes and luminescence were monitored. Thermal neutrons were found to induce both attenuation increases and luminescence in all three fiber types. Fibers made of lead silicate with borosilicate cladding were found to develop a permanent attenuation increase of greater than 300 dB/km, making the fiber useless for most communication systems.

26660 (AD-A—042579) **State of the art in fiber optics communications and data transfer. Interim report.** McCormack, R.G.; Croisant, W.J.; Lam, P.C. (Army Construction Engineering Research

Lab., Champaign, Ill. (USA)). Jul 1977. 42p. (CERL-IR-E—111). NTIS PC A03/MF A01.

This report addresses the state of the art of fiber optic communications as related to U.S. Army Corps of Engineers military construction. It discusses the general capabilities of commercially available fiber optics and summarizes the research and development work being done in the area by other Department of Defense and U.S. Government agencies. Potential Corps of Engineers usage of fiber optics is discussed, and nuclear radiation hardening aspects are summarized. Interfacing optical fibers with electronics is discussed along with factors which limit the performance of fiber optics data transmission links. (Author)

CHEMISTRY

ANALYTICAL AND SEPARATIONS CHEMISTRY

REFER ALSO TO CITATION(S) 25637, 25670, 27017

26661 (HEDL-SA—1258) **Laboratory quality assurance and its role in nuclear fuel reprocessing and refabrication.** Delvin, W.L. (Hanford Engineering Development Lab., Richland, Wash. (USA)). Sep 1977. Contract EY-76-C-14-2170. 31p. (CONF-771031—11). Dep. NTIS, PC A03/MF A01.

From 21. conference on analytical chemistry in energy technology; Gatlinburg, TN, USA (4 Oct 1977).

For the overall quality assurance (QA) program to be fully effective, the principles of QA must be applied to the operation of the analytical chemistry laboratory itself. This paper shows how QA is used at HEDL to produce confidence in each analytical result. Use of QA has resulted in the following benefits: poor laboratory practices have been found and eliminated, and an already adequate record system was improved even further. (DLC)

ACTIVATION AND NUCLEAR REACTION PROCEDURES

REFER ALSO TO CITATION(S) 25668, 25900

CHEMICAL PROCEDURES

REFER ALSO TO CITATION(S) 25681

26662 (CONF-770504—, pp 135-158) **Recent advances in analytical electron microscopy.** Fraser, H.L. (Univ. of Illinois, Urbana). Oct 1977.

From 14. annual proceedings on electron microscopy; Ames, IA, USA (12 May 1977).

In Proceedings of the 14th annual electron microscopy colloquium.

Analytical electron microscopy is being increasingly applied to problems in materials and other sciences. This paper presents an outline of a number of investigations into the application of analytical electron microscopy that have been undertaken at the University of Illinois. It deals in part with increases in usable foil thickness, defect imaging, microdiffraction and microchemistry.

26663 **Method and equipment for the continuous determination of the content of burnable components in powder form bulk goods.** Kluge, H.; Busch, H. (to STEAG Kernenergie G.m.b.H., Essen (Germany, F.R.)). German(FRG) Patent 2,249,651/C/. 20 Jan 1977. 7p. (In German).

The invention is a method which very simply and accurately continuously measures the non-combusted carbon content in fly ash from combustion plants or very generally burnable components in powder form bulk goods. A bulk material with constant temperature is brought together with an air stream of constant quantity and time unit whose constant temperature is different to the former, and the thus formed mixture is subjected to complete combustion. The combustion parameters are essentially kept constant by varying the amount of bulk material. The temperature of the mixture before the combustion is subject to relatively large deviations regarding temperature even with small changes of concentration of burnable components, so that the difference between the air stream temperature and that of the air-bulk good mixture prior to combustion can be recorded as measure for the concentration of burnable component. The equipment to carry out the method consisting of a reaction chamber for complete combustion, mixing chamber, the necessary in and outlets and dosing devices, preheater for fresh air and dust, as well as temperature measuring places and recording equipment, are also part of the patent.

RADIOMETRIC AND RADIOCHEMICAL PROCEDURES

REFER ALSO TO CITATION(S) 25670

SPECTRAL PROCEDURES

REFER ALSO TO CITATION(S) 25669, 25671, 25673, 25813, 25900, 25903, 26700, 26837, 26839

26664 **Determination of trace elements in soft, hard, and saline waters by the inductively coupled plasma, multi-element atomic emission spectroscopic (ICP-MAES) technique.** Winge, R.K.; Fassel, V.A.; Kniseley, R.N.; DeKalb, E.; Haas, W.J. Jr. (Ames Lab., IA). *Spectrochim. Acta, Part B;* **32**: 327-345(1977).

Analytical methods capable of determining natural and aberrant concentrations of the chemical elements in our nation's water resources are essential for maintenance of the water qualities required for public water supplies, for habitat of aquatic biota, and for industrial and agricultural use. Simultaneous determinations of 20 or more elements at trace concentration levels may be required in real time to provide adequate protection of water supplies and to detect discharge of noxious materials into various systems. The ICP-MAES technique allows quantitative determinations, without preconcentration, of most elements at concentrations below EPA recommended criteria levels for public water supplies and for continuous use irrigation water. Stray light problems arising in the analyses of hard waters are discussed and the effect of stray light on the various analytical lines are quantitated.

SEPARATION PROCEDURES

REFER ALSO TO CITATION(S) 25669, 25781, 25900, 26933

26665 (LA—7083) **Cation exchange of 53 elements in nitric acid.** Marsh, S.F.; Alarid, J.E.; Hamond, C.F.; McLeod, M.J.; Roensch, F.R.; Rein, J.E. (Los Alamos Scientific Lab., N.Mex. (USA)). Feb 1978. 10p. Dep. NTIS, PC A02/MF A01.

Cation-exchange distribution data are presented for 53 elements from 3 to 12M HNO_3 for three strong-acid resins, having cross-linkages of 8%, 4%, and macroporous. Data obtained by 16- to 18-h dynamic batch contacts are compared to cation-exchange distribution data from strong HCl and $HClO_4$.

26666 (MLM—2490) **Recovery and purification of uranium-234 from aged plutonium-238.** Keister, P.L.; Figgins, P.W.; Watrous, R.M. (Mound Lab., Miamisburg, Ohio (USA)). 20 Jan 1978. Contract EY-76-C-04-0053. 18p. Dep. NTIS, PC A02/MF A01.

The current production methods used to recover and purify uranium-234 from aged plutonium-238 at Mound Laboratory are presented. The three chemical separation steps are described in detail. In the initial separation step, the bulk of the plutonium is precipitated as the oxalate. Successively lower levels of plutonium are achieved by anion exchange in nitrate media and by anion exchange in chloride media. The procedures used to characterize and analyze the final U_3O_8 are given.

26667 (RFP—2716) **Design and operation of air-lift, circulated, cascade dissolver systems.** Tesitor, C.N. (United Nuclear Industries, Inc., Richland, Wash. (USA)). [nd]. Contract EY-76-C-04-3533. 18p. Dep. NTIS, PC A02/MF A01.

A continuous, cascade dissolver system, using an air-lift pump for circulation and suspension of solid particles has been developed. This dissolver system has been used to dissolve plutonium oxide, incinerator ash and other residues generated during the chemical processing of plutonium. An integral part of the dissolver system development involved the design and fabrication of a reliable continuous feed system for the dissolver.

26668 **Removal of sulfur dioxide from gases using activated carbon at elevated temperatures.** Mukhlenov, I.P.; Lesokhin, I.G.; Buzanova, G.N.; Rumyantseva, E.S; Vinnikov, L.I. *Sov. Chem. Ind. (Engl. Transl.);* **9**: No. 9, 708-709(Sep 1977).

Translated from Khim. Prom-st. (Moscow); No. 9, 679-680(1977).

Results are presented from an investigation of the kinetics and dynamics of SO_2 sorption by activated carbon from a humid gas-air stream at an elevated temperature (100°C). Methods for regenerating the carbon were investigated to obtain basic data for developing an industrial system for removing sulfur dioxide from gases.

INORGANIC AND PHYSICAL CHEMISTRY

CHEMICAL AND PHYSICOCHEMICAL PROPERTIES

REFER ALSO TO CITATION(S) 25813, 26114

26669 (AD-A—042273) **Coherent anti-stokes Raman spectroscopy. Final report.** Byer, R.L.; Henesian, M.A. (Stanford Univ., Calif. (USA). Edward L. Ginzton Lab.). Mar 1977. Contract N00014-75-C-0894. 20p. (GL—2684). NTIS PC A02/MF A01.

The first high resolution cw CARS measurements of H2, D2 and CH4 have been carried out. The preliminary experimental results have verified the predicted CARS signal strengths and CARS lineshapes. The measurements have shown that ultra-high resolution Raman spectroscopy by the cw CARS method is a very useful spectroscopic tool.

26670 (BNL—23550) **Rate parameters for the reactions of formaldehyde with H-atoms and O-atoms over the temperature range 250 to 470 K.** Klemm, R.B. (Brookhaven National Lab., Upton, N.Y. (USA)). 1977. Contract EY-76-C-02-0016. 20p. (CONF-771149—1). Dep. NTIS, PC A02/MF A01.

From Combustion Institute Eastern State meeting; Hartford, CT, USA (10 Nov 1977).

Absolute rate coefficients for the reaction of O-atoms and H-atoms with formaldehyde were determined over the temperature range of 250 to 500 K. Rate parameters were determined from plots of log k vs 1/T which were found to follow the linear Arrhenius behavior: $H + H_2CO : k_1 (T) + (4.2 +- 2.0) \times 10^{-11} \exp(-3820 +- 160/RT)$ $cm^3 molec^{-1} S^{-1}$, and $O + H_2CO : k^2(T) + (5.4 +- 0.9) \times 10^{-12} \exp(-1910 +- 100/RT)$ $cm^3 molec^{-1} s^{-1}$. These results are compared with those of previous studies and further discussed in terms of a formaldehyde conversion mechanism.

26671 (IS-M—125) **Excess Gibbs free energy and the activity coefficients of the $Nd(NO_3)_3$—HNO_3—H_2O system at 25°C.** O'Brien, W.G.; Rautista, R.G. (Ames Lab., Iowa (USA)). 1977. Contract W-7405-ENG-82. 41p. (CONF-780305—5). Dep. NTIS, PC A03/MF A01.

From Division of fuel chemistry meeting; Anaheim, CA, USA (12 Mar 1978).

Values of the stability constants and the fractions of the total metal concentration existing as nitrate complexes obtained from the literature together with the vapor pressure and nitrate electrode data for pure neodymium nitrate solutions were combined through the Gibbs-Duhem Equation to yield the activity and the activity coefficient of the free neodymium (III) ion. The vapor pressures of binary electrolyte solutions consisting of neodymium nitrate and nitric acid were measured. Harned's activity coefficient equations for a binary electrolyte were used to model the data. The excess Gibbs free energy of the electrolyte mixtures was also calculated. The hydrogen ion activity in the neodymium nitrate-nitric acid binary electrolyte solutions was determined using the pH electrode. The nitrate ion electrode was used to measure the nitrate ion activity of the neodymium nitrate-nitric acid binary electrolyte solutions. A strong liquid junction potential generated at the reference electrode by the presence of the H^+ ions was eliminated by careful calibration of the nitrate electrode with nitric acid. (9 tables, 14 figures)

26672 Kinetics of endothermic decomposition reactions. II. Effects of the solid and gaseous products. Searcy, A.W.; Beruto, D. (Univ. of California, Berkeley). *J. Phys. Chem.;* **82**: No. 2, 163-167(26 Jan 1978).

Decomposition rates are predicted to decrease linearly with increased pressure of the product gas if a chemical step for the gaseous component of the reaction is rate limiting, but to be a constant function of the difference between the reciprocals of the equilibrium decomposition pressure and the product gas pressure if a step for the solid reaction component is rate limiting. An equation which was derived by Sandry and Stevenson to describe the effect of tubular capillaries on the rates of vaporization from surfaces of known vaporization coefficients is adapted to describe the effect of porous solid barriers on the rates of decomposition reactions. The equations for the effect of barrier thickness take two forms, one form when a chemical step for the solid reaction component is slowest and another form when a step for the gaseous component is slowest. Equations are also described for use when both the product gas pressure and barrier thickness influence the reaction rate. The various rate equations are functions only of the activities of the reaction components, of measured rates in vacuo with negligible barriers, and of measurable transmission properties of the barriers. The theory is applied to interpret data for calcite decomposition.

26673 Binding of Li^+ to Lewis bases in the gas phase. Reversals in methyl substituent effects for different reference acids. Woodin, R.L.; Beauchamp, J.L. (California Inst. of Tech., Pasadena). *J. Am. Chem. Soc.;* **100**: No. 2, 501-508(18 Jan 1978).

Gas-phase binding energies of Li^+ to ten simple Lewis bases have been determined by ion cyclotron resonance spectroscopy. Species studied include water, methanol, dimethyl ether, formaldehyde, ammonia, the methylamines, hydrogen cyanide, and benzene. Equilibrium constants for reactions involving Li^+ transfer between different base pairs are determined and converted to free energies. Enthalpies are calculated from the measured free energies and calculated entropies. The results are compared to data for systems with H^+, K^+, CH_3^+, $CpNi^+$, and $(Me_3)B$ as the reference acid. Reversals in methyl substituent effects are noted and discussed for different reference acids. The data also allow detailed evaluation of recent theoretical work on Li^+ affinities.

26674 Peripheral metal complexes: chlorophyll "isomers" with magnesium bound to the ring E β-keto ester system. Scheer, H.; Katz, J.J. (Argonne National Lab., IL). *J. Am. Chem. Soc.;* **100**: No. 2, 561-571(18 Jan 1978).

Peripheral magnesium complexes of methyl pheophorbides a and b, bacteriomethyl pheophorbide a, bacteriopheophytin a, and protopheophytin a have been prepared and characterized by UV-vis, IR, ^1H NMR, and luminescence spectroscopy. In these compounds, Mg is bound to the peripheral β-keto ester system present in most chlorophylls rather than to the central tetrapyrrole cavity as in the chlorophyll proper. The ligand exchange reactions at Mg have been characterized, and the equilibrium between the peripheral complexes and their free ligands has been studied over the concentration range 10^{-7} to 10^{-2} M. ΔG^0 for complex formation has been determined by ^1H NMR spectroscopy.

26675 Determination of local structures of platinum uridine blues and purples by extended x-ray absorption fine structure spectroscopy. Teo, B.K. (Bell Labs., Murray Hill, NJ); Kijima, K.; Bau, R. *J. Am. Chem. Soc.;* **100**: No. 2, 621-624(18 Jan 1978).

The extended x-ray absorption fine structure analysis of a purple compound derived from the reaction of cis-$Pt(cyclopropylamine)_2Cl_2$ with uridine and of a blue compound derived from the reaction of cis-$[Pt(NH_3)_2(H_3O_2)]^{2+}$ with uridine were reported. The local platinum coordination of the two compounds involves Pt-X (where X = N or O) bonds of approximately 2.00 A and a partial but distinct Pt—Pt bond of approximately 2.90 A. The coordination sphere is probably cis-$Pt(amine)_2XY$ where X,Y = N_3, O_2, or O_4 of the uridinato ligand. (JSR)

26676 Synthesis and characterization of $[(eta^5\text{-}C_5H_5)V(CO)_3H]^-$, a new anionic vanadium carbonyl hydride, and a study of its reduction reaction with organic halides. Observation of a free-radical chain process having an extremely rapid metal-to-carbon hydrogen transfer step. Kinney, R.J.; Jones, W.D.; Bergman, R.G. (California Inst. of Tech., Pasadena). *J. Am. Chem. Soc.;* **100**: No. 2, 635-637(18 Jan 1978).

The preparation and certain reactions of a new anionic vanadium carbonyl hydride, $[(eta^5\text{-}C_5H_5)V(CO_3H]^-$ (1), which may be prepared from commercially available $(eta^5\text{-}C_5H_5)V(CO)_4$ is reported. THF or acetonitrile at room temperature, replaces halogen by hydrogen in a wide range of alkyl, vinyl, and acyl halides. These reactions appear to proceed by a radical chain mechanism which involves an exceedingly high vanadium-to-carbon hydrogen transfer rate constant.

26677 Metal—metal bonded clusters in transition metal groups 3 and 4. Synthesis and structure of three M_6X_{12}-type clusters for scandium and zirconium. Corbett, J.D.; Daake, R.L.; Poeppelmeier, K.R.; Guthrie, D.H. (Ames Lab., IA). *J. Am. Chem. Soc.;* **100**: No. 2, 652-654(18 Jan 1978).

Cluster synthesis reactions in zirconium and scandium binary systems with halogens were carried out under very reducing conditions near 800 to 1000°C for several weeks using welded Ta tubing as a container metal. Three cluster compounds were discovered with the stoichiometry of ZrI_2, $ZrCl_{2.5}$, and $Sc_{1.17}Cl_2$. According to the crystal data these compounds are properly Zr_6I_{12}, $(Zr_6Cl_{12}^{3+})(Cl^-)_3$, and $Sc^{2+}(Sc_6Cl_{12}^{3-})$. Crystal and bonding data are tabulated. The Zr_6I_{12} and $Sc(Sc_6Cl_{12})$ both have structures consisting of essentially ccp halogen layers between which triangles of metal atoms occur in pairs and are drawn together through metal-metal bonding to generate M_6 trigonal antiprisms. (JSR)

26678 Complete catalytic oxidation of vapor mixtures containing phenol and hydrogen sulfide. Kaliberdo, L.M.; Makarova, V.V.; Eppel, S.A.; Karpenko, N.N.; Torgasheva, A.A.; Suvorova, N.G. *Sov. Chem. Ind. (Engl. Transl.);* **9**: No. 9, 699-700(Sep 1977).

Translated from Khim. Prom-st. (Moscow); No. 9, 671-673(1977).

The activity of oxide (GIPKh-105, K-670, aluminum-copper-chromium) and metallic (AP-56, M-2, sulfided Pd) catalysts in the complete oxidation of phenol and hydrogen sulfide contained in vapor mixtures was investigated. The effect of the concentrations of oxygen and sulfur compounds (H_2S, sulfur oxides) on the activity of the catalysts was studied. It was shown that in the presence of sulfur compounds, catalyst activity decreases in the phenol oxidation reaction. Complete conversion of H_2O from phenol is achieved on oxide catalysts (GIPKh-105, aluminum-copper-chromium) at 550°C, on AP-56 at 500°C, on M-2 at 400°C. 1 tabulation, 3 figures, 7 references.

26679 Decomposition rate of nitric oxide on alumina surface in the temperature range 920 to 1220°K. Mori, Y.; Ohtake, K. (Tokyo Inst. of Tech., Meguro, Japan). *Combust. Sci. Technol.;* **16**: No. 1-2, 11-20(Jul 1977).

The decomposition rate of NO on the alumina surface is obtained by two different experimental methods in the temperature region of 920 to 1220°K. One is carried out by a laminar convective mass transfer experiment of the fuel lean combustion gas including

various quantities of NO in a horizontal alumina pipe. The other is by an experiment of introducing such mixed gases as AR-NO, Ar-NO-CO and Ar-NO-H_2 flowing through a packed bed of alumina pebbles. First, the decomposition rate of NO is proved to be of zeroth order on the NO concentration when it is larger than about 300 ppM. However, in the case of NO concentration lower than about 300 ppM, all the reaction rates come to depend on the NO concentration. Secondly, the effect of the reducing species such as CO and H_2 on the decomposition rate was studied by adding CO and H_2 and, depending on the amount of CO and H_2 included, the rate was seen to increase up to 3 to 12 times that in the case without these reducing species.

26680 Profile analysis of powder neutron diffraction data: its scope, limitations, and applications in solid state chemistry. Cheetham, A.K. (Chemical Crystallography Lab., Oxford); Taylor, J.C. *J. Solid State Chem.;* **21**: 253-275(1977).

Profile analysis of powder neutron diffraction data is reviewed. Applications of the technique are comprehensively tabulated and some recent examples are described in detail. Future developments and limitations of the method are also discussed, including Fourier analysis, profile refinement of X-ray data, and pulsed neutron sources.

26681 Low-temperature oxidation of calcium by water vapor. Nissen, D.A. (Sandia Labs., Albuquerque, NM). *Oxid. Met.;* **11**: No. 5, 241-261(1977).

The oxidation kinetics of calcium in water vapor have been studied over the temperature range 25 to 300°C. There is a change in the form of the oxidation kinetics with temperature, from essentially linear at temperatures below 150°C to logarithmic at 300°C. This is coupled with a change in the manner of growth of the oxide layer as well as the chemical composition of the reaction product. In addition, the oxidation rate decreases with temperature, reaching a minimum at about 150°C. At temperatures below 150°C oxidation appears to be a result of the formation of cracks or fissures in the oxide film. Above 150°C no single oxidation mechanism can be deduced.

26682 Single crystal neutron diffraction studies of partially oxidized $K_2Pt(CN)_4Br_{0.3}.3.0H_2O$, $K_2Pt(CN)_4Cl_{0.3}.3.0H_2O$, and $K_{1.75}Pt(CN)_4.1.5H_2O$: new results and a summary. Williams, J.M. (Argonne National Lab., IL). *Ferroelectrics;* **16**: 135-142(1977).

The present status of the structures of the partially-oxidized metal-chain forming compounds $K_2Pt(CN)_4Br_{0.3}.\ 3.0H_2O$, $K_2Pt(CN_4Cl_{0.3}\ .\ 3.0H_2O$ and $K_{1.75}Pt(CN_4\ .\ 1.5H_2O$, as determined by neutron and x-ray diffraction studies, is reviewed. New thermogravimetric analysis resuls are presented which prove that deuterated KCP(Br) normally has water content different from the hydrogenous samples, viz., $K_2Pt(CN)_4Br_{0.3}\ .\ 3.2D_2O$ vs. $K_2Pt(CN)_4Br_{0.3}\ .\ 3.0H_2O$. The relationship of this finding to the previously reported structural results is discussed in detail. Entirely new findings regarding the non-linear Pt-Pt chain observed in $K_{1.75}Pt(CN)_4\ .\ 1.5H_2O$ are presented. While superlattice formation is known to occur for $K_2Pt(CN)_4Br_{0.3}\ .\ 3(H/D)_2O$, no such findings have as yet been observed for cation deficient $K_{1.75}Pt(CN)_4\ .\ 1.5H_2O$, K(def)TCP. Both KCP(Br) and KCP(Cl) are disordered by virtue of the halide ion non-stoichiometry. K(def)TCP is also non-stoichiometric and the asymmetric unit contains three crystallographically distinct $Pt(CN)^{-1.75}_4$ groups, three H_2O molecules (one in disorder), and four K^+ ions (one in disorder).

ORGANIC CHEMISTRY

CHEMICAL AND PHYSICOCHEMICAL PROPERTIES

REFER ALSO TO CITATION(S) 25783, 25792, 26669, 26670, 26674, 26675, 26676, 26678

26683 (UCRL—13808) **Researching an alternate synthesis of triaminotrinitrobenzene.** Ogiachi, N.N. (Teledyne McCormick Selph, Hollister, Calif. (USA)). 14 Nov 1977. Contract W-7405-ENG-48. 41p. Dep. NTIS, PC A03/MF A01.

It would be of considerable interest to the Lawrence Livermore Laboratory (LLL) to be able to obtain chlorine-free triaminotrinitrobenzene (TATB). Current production techniques leave approximately 0.5% residual chlorine in the TATB crystal. The proposed synthesis route consists of five steps. The starting material, 5-nitroisophthalic acid is a commercially available material in the USA. All the reaction reagents and solvents and relatively inexpensive except for tetrahydrofuran used in the final amination step. The tetrahydrofuran could be recycled to reduce its usage. Teledyne was able to complete the first three steps with reasonable yields and purity. However, all reasonable approaches to the nitration of 1.3 diamino-5 nitrobenzene to the tetranitro compound were exhausted without ever isolating reasonable quantities of a crystalline product. The product that was isolated decomposed when dried. Since all practical synthesis routes had been explored without success, LLL and Teledyne agreed to reduce the scope of the effort to what had already been expended.

26684 Hydrogenation of hexene over platinum on alumina vs. platinum in a Na-Y zeolite. Miner, R.S. Jr. (Princeton Univ., NJ); Ione, K.G.; Namba, S.; Turkevich, J. *J. Phys. Chem.;* **82**: No. 2, 214-218(26 Jan 1978).

In order to study the efficacy of zeolites as supports, several platinum H—Y zeolites were prepared by ion exchanging an H—Y zeolite with $Pt(NH_3)_4Cl_2$ and reducing these products with hydrazine hydrate (A, B, C). Another preparation was made by adsorbing 32-A platinum sol on the zeolite crystallites (D). These catalysts were studied for hydrogenation and isomerization of hexene-1, ethylene hydrogenation, hydrogen chemisorption, and poison titration. They were compared with monodisperse Pt (32 A diameter) on alumina. A marked difference was found between the behavior of hexene-1 with the platinum-in-zeolite and with the platinum-on-alumina.

26685 Unsaturated carbenes from primary vinyl triflates. IX. Intramolecular rearrangement via free carbenes. Stang, P.J. (Univ. of Utah, Salt Lake City); Fox, D.P.; Collins, C.J.; Watson, C.R. Jr. *J. Org. Chem.;* **43**: No. 2, 364-365(20 Jan 1978).

The mechanism and exact nature of the intermediates in the base-initiated rearrangement of arylvinyl triflates were examined to determine if the reaction proceeds via a carbenoid or the unencumbered carbene. A clear-cut difference was noted in the intramolecular rearrangement of aryl-substituted unsaturated carbenes, with the reaction proceeding via a carbenoid in the case of arylvinyl halides and via the free carbene in the case of arylvinyl triflates. (JSR)

26686 Carbon magnetic resonance spectroscopy on carbon-13-labeled uracil in 5S ribonucleic acid. Hamill, W.D. (Univ. of Utah, Salt Lake City); Grant, D.M.; Cooper, R.B.; Harmon, S.A. *J. Am. Chem. Soc.;* **100**: No. 2, 633-635(18 Jan 1978).

The carbon-13 nuclear magnetic resonance spectra of the ^{13}C-enriched C-4 uridine carbons in 5S ribosomal ribonucleic acid of Salmonella typhimurium, strain JL-1055, was obtained. The most striking feature of the 5S RNA spectrum was the large number of well-resolved lines in the uridine band covering a chemical shift range of approximately 3.6 ppM. This data was used to obtain information on the secondary structure. The number of uridines involved in secondary interactions is estimated to be at least 75% and may be as high as 95%. (JSR)

26687 Direct synthesis of anilides from nitroarenes. Ho, T.L. (Brookhaven National Lab., Upton, NY). *J. Org. Chem.;* **42**: No. 23, 3755(11 Nov 1977).

Experimental results have shown that nitroarenes are converted directly to anilides in a heated system with $Mo(CO)_6$ and carboxylic acid. Heating $Mo(CO)_6$ with carboxylic acid produces the reducing species Mo(II). (JSR)

26688 Distinctive catalysis by phosphonium and sulfonium compounds in low-temperature liquid-phase hydrocarbon oxidation. Ohkubo, K.; Yoshinaga, K. (Kumamoto Univ, Kurokami, Jpn). *Bull. Jpn. Pet. Inst.;* **19**: No. 1, 73-80(May 1977).

The oxidation catalysis of phosphonium and sulfonium compounds possessing various kinds of counteranions was investigated in the low-temperature homogeneous liquid-phase oxidation of nonpolar tetralin and polar benzaldehyde with particular reference to the initial oxidation mechanism. The detailed approach to the initiation mechanism on the basis of uv spectroscopic measurements of the interaction between the onium catalyst and O_2, molecular orbital calculations of onium catalysts, the simulation analysis of the mechanism, etc. led to a conclusion that the partially electron-occupied d-orbitals of phosphorus or sulfur atom in the onium catalyst is favorably deposited for the interaction of O_2 so as to activate the latter through the charge transfer from the catalyst to O_2. 18 refs.

26689 Transport of liquids and gases through coatings. Klopfer, H. *Goldschmidt Informiert;* **3**: No. 38, 8-15(Nov 1976). (In German).

Swelling and pressureless water transport through different polymers, H_2O transport under pressure, osmosis phenomena in this context, and the activity of water molecules are described.

ISOTOPE EFFECTS

26690 (AD-A—042618) **Deuterated fluids: deuterated synthetic hydrocarbon fluid and grease. Final report.** Conte, A.A. Jr; Rebuck, N.D. (Naval Air Development Center, Warminster, Pa. (USA). Air Vehicle Technology Dept.). 1 Mar 1977. 20p. (NADC—77027-30). NTIS PC A02/MF A01.

The replacement of hydrogen atoms with deuterium atoms in a synthetic hydrocarbon lubricant has been shown to substantially improve its oxidation resistance via the deuterium isotope effect. In addition, it was determined that the anti-friction bearing performance life of a MIL-G-81322 grease, formulated with the deuterium

substituted fluid, increased significantly at 400 F (478 K). The results of this investigation are presented in this final report along with recommendations for the utilization of the deuterium isotope effect in developing a super clean instrument bearing grease. (Author)

ISOTOPE EXCHANGE AND ISOTOPE SEPARATION

26691 Priori calculations on isotopic exchange equilibria. DeFrees, D.J.; Hassner, D.Z.; Hehre, W.J.; Peter, E.A.; Wolfsberg, M. (Univ. of California, Irvine). *J. Am. Chem. Soc.;* **100**: No. 2, 641-643(18 Jan 1978).

According to molecular orbital theory, the lowest lying acceptor orbital of a methyl group is CH antibonding. It follows, therefore, that transfer of electron density into the group will lead to a weakening of its CH linkages. A like result derives from resonance arguments, $H_3C\text{-}X^-$ reversible $H_2C(H^-)=X$ reversible, etc., and has been aptly termed "negative hyperconjugation." The observation of significant β-deuterium isotope effects for the gas phase ion-molecule equilibria has recently been cited as evidence for such an effect. We now present theoretical results based on ab initio molecular orbital calculations which further support such an interpretation.

PHOTOCHEMISTRY

26692 (LA-UR—77-2790) **Laser synthetic chemistry.** Leary, K.M.; Clark, J.H. (Los Alamos Scientific Lab., N.Mex. (USA)). 1977. Contract W-7405-ENG-36. 11p. (CONF-771040—10). Dep. NTIS, PC A04/MF A01.

From Electro-Optical systems conference; Anaheim, CA, USA (25 Oct 1977).

By choosing the laser, wavelength, and starting materials, virtually any free radical species can be produced, leading to new compounds. SF_5NF_2 was prepared in this way. Laser-driven catalysis can be used to increase the efficiency of the photons. It is shown that in the photolytic isomerization of cis-2-butene to trans-2-butene using carbonyl sulfide (OCS), the catalytic species is free $S(^3P)$ atoms. (DLC)

RADIATION CHEMISTRY

26693 (AD-A—042525) **Radiation degradation susceptibility of several related polymers. Research and development technical report.** Helbert, J.N.; Poindexter, E.H.; Stahl, G.A.; Chen, R.C.; Pittman, C.U. Jr. (Army Electronics Command, Fort Monmouth, N.J. (USA)). Jul 1977. 9p. (ECOM—4504). NTIS PC A02/MF A01.

Radiation degradation is observed for irradiated poly(methyl alpha-chloroacrylate) (PMCA), poly(methacrylonitrile) (PMCN), and poly(methyl methacrylate) (PMMA) by gel permeation chromatography (GPC). Molecular weight averages obtained by GPC on irradiated sample solutions indicate cross-linking also occurs in irradiated PMCA and PMCN. G(s) is determined to be 6-8 and G(x) 1-2 for PMCA, while ((G(s)-G(x) is 2.1 for irradiated PMCN. GPC data for irradiated poly(methacrylic anhydride) and poly(acrylic anhydride) model polymers indicate that these polymers are less sensitive to radiation degradation than the related polymers. The combination of results suggests that the main-chain scission process is not initiated by decarboxylation, but by a mechanism involving methylene radicals procuded by C-H bond dissociation on the ester-methyl or alpha-methyl polymer groups. (Author)

26694 (UR/3490/LCP—6) **Development of methods for determining organic free radical structures by electron spin resonance and application to the radiation chemistry of nucleic acid model compounds.** Fouse, G.W. Jr. (Rochester Univ., N.Y. (USA)). 1977. Contract EY-76-C-02-3490. 199p. Dep. NTIS, PC A09/MF A01.

This project was undertaken with the objective of developing more efficient and reliable methods for the analysis of free radicals in organic single crystals. A technique was developed for the rapid calculation of single crystal ESR line positions and intensities. This method, which avoids the time-consuming matrix operations required by conventional methods, has been incorporated into a computer program for determining ESR parameters by the least-squares fitting of digitized ESR spectra. This program has been used to analyze complex spectra arising from a . $CH_2\text{-}CH_2\text{-}O\text{-}PO_3H^-$ radical trapped in O-phosphorylethanolamine. A method was developed for the estimation of variance and covariance of eigenvectors and eigenvalues of experimentally-determined tensors. This error analysis is quite general, and may be applied to any tensors which can be determined by the non-linear least-squares fitting of ESR data. Monte-Carlo simulations have been employed to estimate the limitations of the approximation method. This error analysis has been included in the analysis of two phosphite radicals, $^-O_2\text{-P-OX}$, found in single crystals of O-phosphorylethanolamine. To aid in the formulation and evaluation of free radical models, a generalized method for the calculation of theoretically-expected hyperfine coupling tensors for arbitrary radical models was developed. Tensors are calculated for a furan-type radical which may be found in 5′ dCMP. These calculated tensors are compared with tensors determined by an ENDOR experiment. Two ENDOR studies were done, one in 5′ dCMP, the other in L-asparagine. The observed radical in 5′ dCMP is allylic, characterized by coupling to three α-hydrogens. In L-asparagine, the dominant room-temperature radical has the form $CO(NH_2)CHCH(N^+H_3)CO_2^-$. In both these studies, a series of molecular orbital calculations were performed as a means of substantiating the postulated radical structures.

26695 Reactions of thiophene with radiolytically produced radicals. I. The hydroxyl radical. Saunders, B.B.; Kaufman, P.C.; Matheson, M.S. (Argonne National Lab., IL). *J. Phys. Chem.;* **82**: No. 2, 142-150(26 Jan 1978).

We have investigated the reactions of aqueous solutions of thiophene with radiolytically generated hydroxyl radicals, measured the rate constant with thiophene, the UV and visible spectra of the 2-hydroxythienyl radical, and the rate of disappearance of the intermediates. The rate of the addition of OH to the 2 position in thiophene is nearly diffusion controlled, $k(OH + Th) = 8.2 \times 10^9\ M\ s^{-1}$. In neutral solutions 2-thiolactone and 2,2′-bithiophene are the major products and result from reactions of 2-hydroxythienyl radicals with each other. In basic solutions, the C—S bond of the 2-hydroxythienyl radical is cleaved and the ring opened. In spite of the similarities between benzene and thiophene, the greater reactivity of thiophene results in considerable differences in the hydroxyl radical reaction sequence of the two compounds.

26696 Reactions of thiophene with radiolytically produced radicals. II. The solvated electron and the hydrogen atom. Saunders, B.B. (Argonne National Lab., IL). *J. Phys. Chem.;* **82**: No. 2, 151-154(26 Jan 1978).

The reactions of the solvated electron and the hydrogen atom with thiophene in aqueous and alcoholic solutions have been investigated. The rate of the addition of H to thiophene is nearly diffusion controlled, $k(H + Th) = 9 \times 10^9\ M^{-1}s^{-1}$, and the rate of e⁻/sub aq/ with thiophene is quite slow, $k(e^-/sub\ aq/ + Th) = 4 \times 10^7\ M^{-1}s^{-1}$. The anion of thiophene was not observed in the solvated electron systems. Both the H atom and solvated electrons react to produce the same radical intermediate, 2-hydrothienyl radical, whose UV and visible spectra were measured. This radical disappears at the same rate in both systems, but the products of the two systems are not the same. The major product of the reaction of e⁻/sub aq/ with thiophene is 2,2′-bithiophene. However, the products in the H system indicate that the thiophene ring is destroyed subsequent to the disappearance of the 2-hydrothienyl radical.

26697 Effects of γ-ray radiation on the thermal decomposition of lithium aluminum hydride powder. Herley, P.J.; Schaeffer, D.A. (State Univ. of New York, Stony Brook). *J. Phys. Chem.;* **82**: No. 2, 155-163(26 Jan 1978).

The thermal decomposition kinetics of unirradiated and γ-ray irradiated powdered $LiAlH_4$ have been determined in the temperature range 115 to 150°C. The sigmoid, noncondensable gas pressure vs. time curves consist of the following stages: first, an induction period with an irreproducible "puff" superimposed; second, an acceleratory stage; and, finally, a third or decay stage terminating in a period of slow linear gas evolution. All of the curves, both irradiated and unirradiated, can be described by a cubic expression over the acceleratory period and by a unimolecular law over the decay stage. The induction period is reduced by irradiation prior to decomposition and the acceleratory period decomposition occurs at an increased rate, both of these effects increasing with irradiation dose. The increase in acceleratory period rate can be attributed to the formation of additional decomposition sites; an increase in the rate of growth of each nucleus; or to a combination of these factors. Analyses show that the irradiation has increased the rate of conversion of potential decomposition sites to active decomposition sites. Similar activation energies (94.3 and 99.5 +- 4.6 kJ/mol) and (87.1 and 80.5 +- 4.6 kJ/mol) were obtained for both the acceleratory and the decay stages for unirradiated and irradiated crystals, respectively, within experimental error. Values of the respective induction period activation energies (116.8 and 119.0 +- 4.6 kJ/mol) are slightly higher than would be predicted if only one reaction were involved. This suggests that the initial "puff" process may influence the induction period activation energy. This influence may be due to a release of additively complexed ether during this period. Taken together these observations suggest that the same processes occur for both irradiated and unirradiated $LiAlH_4$, but the rate constants are increased by prior radiation.

26698 Trapping and stabilization of hydrogen atoms in intracrystalline voids. Defected calcium fluorides and Y zeolite surfaces. Iton, L.E.; Turkevich, J. (Argonne National Lab., IL). *J. Phys. Chem.;* **82**: No. 2, 200-214(26 Jan 1978).

Using EPR spectroscopy, it has been established that H. atoms are absorbed from the gas phase when CaF_2 powder is exposed to H_2 gas in which a microwave discharge is sustained,

being trapped in sites that provide unusual thermal stability. The disposition of the trapped atoms is determined by the occluded water content of the CaF_2. For ultrapure CaF_2, atoms are trapped in interstitial sites having A_0 = 1463 MHz; for increasing water content, two types of trapped H. atoms are discriminated, with preferential trapping in void sites (external to the regular fluorite lattice) that are associated with the H_2O impurity. Characterization of these "extra-lattice" H. (and D.) atoms is presented, and their EPR parameters and behavior are discussed in detail. Failure to effect H.-D. atom exchange with D_2 gas suggests that atoms are not stabilized on the CaF_2 surface. H. atoms are trapped exclusively in "extra-lattice" sites when the water-containing CaF_2 is γ irradiated at 77 or 298 K indicating that the scission product atoms do not escape from the precursor void region into the regular lattice. It is concluded that the thermal stability of the "extra-lattice" atoms, like that of the interstitial atoms, is determined ultimately by the high activation energy for diffusion of the H. atom through the CaF_2 lattice. For comparison, results obtained from H. atoms trapped in γ-irradiated rare earth ion-exchanged Y zeolites are presented and discussed also; these "surface" trapped atoms do not exhibit great thermalstability. Distinctions in the H. atom formation mechanisms between the fluorides and the zeolites were deduced from the accompanying paramagnetic species formed. The intracavity electric fields in the Y zeolites have been estimated from the H. atoms hfsc contractions, and are found to be very high, about 1 V/A.

RADIOCHEMISTRY AND NUCLEAR CHEMISTRY

REFER ALSO TO CITATION(S) 26933

PROPERTIES OF RADIOACTIVE MATERIALS

REFER ALSO TO CITATION(S) 26971

26699 (AD—239162) **Tracer experiments on the reaction of UH_3 in water.** Agarwala, U.; Hung, J.B.; Taube, H. (Chicago Univ., Ill. (USA)). 30 Sep 1960. Contract nonr212116. 6p. NTIS PC A02/MF A01.

COMBUSTION CHEMISTRY

26700 (BMI—1982) **Laser spectroscopy for continuous combustion applications.** Barnes, R.H.; Boiarski, A.A.; Kircher, J.F. (Battelle Columbus Labs., Ohio (USA)). 30 Sep 1977. Contract W-7405-ENG-92-088. 47p. Dep. NTIS, PC A03/MF A01.

Laser spectroscopy including both fluorescence and Raman techniques are being developed for application to continuous combustion systems. Feasibility of in-situ flame measurement of NO_2 has been demonstrated by observation of NO_2 in a one atmosphere methane/air flame. Excitation fluorescence spectra were obtained in the wavelength region from about 4300 to 5000A using a tunable dye laser pumped with a pulsed N_2 laser. For laser Raman studies codes have been developed for CO, CO_2, and H_2O. The temperature correction required to obtain species number density from the Raman measurement under combustion conditions is demonstrated.

26701 (PB—269653) **Review of laser raman and fluorescence techniques for practical combustion diagnostics. Final report on Task 1, October 1976—March 1977.** Eckbreth, A.C.; Bonczyk, P.A.; Verdieck, J.F. (United Technologies Research Center, East Hartford, Conn. (USA)). Jun 1977. Contract EPA-68-02-2176. 175p. NTIS PC A08/MF A01.

The report gives results of a detailed examination of four techniques for practical combustion diagnostics: spontaneous and near-resonant Raman scattering, laser fluorescence, and coherent anti-Stokes Raman scattering (CARS). For diagnosis of highly luminous, particle-laden flames (e.g., in hydrocarbon-fueled primary combustion zones), spontaneous and near-resonant Raman scattering appear to possess a low probability for successful application, even with advanced state-of-the-art laser sources. However, for clean flame diagnostic or probing or environments with modest particulate levels (e.g., some secondary combustion and exhaust/plume regions), spontaneous Raman scattering is very attractive due to its simplicity, high level of understanding, and advanced state of development. Laser fluorescence appears capable of species concentration measurements to 10's of ppM for selected molecules whose absorptions can be saturated. In this way, fluorescence magnitudes do not depend on quenching effects. CARS appears to be capable of sucessful thermometry and majority constituent measurements in practical flame environments, although some jeopardies need to be experimentally investigated. Potential detectivities in the 10-100 ppm range may be possible using sophisticated variants of the CARS technique.

26702 **Theoretical and experimental investigation of the ignition of fuel droplets.** Sangiovanni, J.J.; Kesten, A.S. (United Technologies Research Center, East Hartford, CT). *Combust. Sci. Technol.;* **16**: No. 1-2, 59-70(Jul 1977).

The influence on the self-ignition of single fuel droplets of ambient temperature and oxygen concentration, droplet relative velocity, droplet size, and fuel type was investigated both experimentally and theoretically. Using a unique droplet combustion experimental system, measurements of droplet ignition delay times were obtained for two pure fuels having widely different properties (furfuryl alcohol and butyl alcohol) and two different droplet diameters (200 mu and 300 mu nominal diameter) for representative droplet combustion conditions. A mathematical model describing the development of profiles for fuel vapor, temperature, and oxygen in the boundary layer surrounding a single fuel droplet moving relative to a hot oxidizing atmosphere was used to correlate the observed ignition delay times. Ignition delay times are found to increase substantially with decreasing ambient temperature and to a somewhat lesser degree with increasing droplet diameter and decreasing fuel volatility. A modest tendency for decreasing ignition delay times with increasing droplet relative velocity is noted, but this effect of relative velocity diminishes rapidly with increasing fuel volatility or decreasing droplet size. While the measured effect of ambient oxygen weight fraction on ignition delay times is shown to be negligible, the theoretical correlation shows a decrease in ignition times with decreasing oxygen weight fraction. This lack of agreement is ascribed to an oversimplification in the ignition criterion used in the mathematical model. Differences in predicted ignition delay times using mathematical models based on uniform and nonuniform internal droplet heating are found to be so small that no conclusions can be made regarding the actual mode of droplet heating during the preignition period.

ENGINEERING

GENERAL ENGINEERING

26703 **Testing tar-epoxide-coating materials under practice-like conditions in the laboratory.** Koldewitz, W. *Goldschmidt Informiert;* **3**: No. 38, 21-28(Nov 1976). (In German).

Described are the technical application tests which include laboratory tests, experimental procedure and evaluation, and the resistance tests during stress through water with temperature drops at the same time consisting of experimental procedure, experimental results and evaluation. Illustrated are also the technical application tests in the practice.

FACILITIES AND EQUIPMENT

26704 (CONF-780409—1) **Performance of a high-pressure pulsed water-jet device for fracturing concrete pavement.** Yie, G.G.; Burns, D.J.; Mohaupt, U.H. (Institute of Gas Technology, Chicago, Ill. (USA); Waterloo Univ., Ontario (Canada)). 1978. 32p. of Gas Technology, Chicago, IL.

From 4. international symposium on jet and cutting technology; Canterbury, UK (12 Apr 1978).

The performance of a high-pressure pulsed water-jet system for fracturing concrete pavement is described. Tests were performed with small concrete blocks as well as large (6 x 7.6m) slabs of 15 and 23 cm in thickness, with some of the latter containing steel reinforcing rods. The paper discusses the relationship between the volume of concrete removed, jet parameters (pressure, pulse duration, nozzle size, and standoff distance), and parameters such as slab thickness and distance between jet impingement and free edges of slab.

26705 (LA—6807-PR, pp 60-71) **Reactor and advanced heat transfer technology.** May 1977.

In Energy technology. Progress report, January—March 1977.

A description of the progress in programs in heat pipe design, development, and fabrication for a variety of applications is presented. LASL efforts supporting the investigation of High-Temperature Reactors for process heat applications, and a study effort for a Space Electric Power Supply (SEPS) are described.

26706 (TID—28175) **Strategy for energy conservation through tribology.** Pinkus, O.; Wilcock, D.F. (American Society of Mechanical Engineers, New York). 1977. Contract EC-77-A-31-1030. 186p. Society of Mechanical Engineers, New York, NY.

Tribology is defined as an interdisciplinary science that deals with the physical, chemical, and metallurigal phenomena of interacting surfaces in relative motion. It is concerned with studies of lubrication, friction, wear and the properties of lubricants and bear-

ing materials. A study was conducted to determine the energy conservation potential of tribology research and development programs related to equipment for road transportation, power generation, turbomachinery, and industrial machinery. The study determined that funding of the recommended R and D plan and implementation of its findings offer the potential of conserving up to one tenth of the total U.S. energy consumption. In terms of the 1976 energy expenditure rate based on oil at $12/bbl, this represents a saving of over $16 billion; or nearly one and a half billion bbl of oil per year. Not included in these figures is the payoff in the areas of raw material usage, life of machinery, manufacturing costs, etc., which ultimately translates into substantial additional savings of energy and other national resources. (LCL)

26707 Experimental study of heat exchange in the transcritical region of smooth and rough steam-generating channels. Styrikovich, M.A.; Leont'ev, A.I.; Polonskii, V.S.; Malashkin, I.I. (High-Temperature Institute, Academy of Sciences of the USSR). *High Temp. (USSR) (Engl. Transl.);* **15**: No. 3, 472-477(Nov 1977).

Experiments are carried out illustrating the high effectiveness of artificial roughness in the intensification of heat exchange in a two-phase dispersed flow regime. In the range of parameters investigated, the Nusselt number for the rough pipe increased to a value as much as four times higher than that for the smooth pipe.

26708 Structural integrity of fiber/epoxy vessels by acoustic emission. Hamstad, M.A.; Chiao, T.T. (Univ. of California, Livermore). *SAMPE Q.;* **8**: No. 1, 1-15(Oct 1976).

The application of acoustic emission to the prediction of the burst pressure of vessel wound with organic fiber/epoxy filament has been studied. Experimental aspects of this work included determination of longitudinal and shear velocities, propagation signal losses, resonant vs non-resonant acoustic emission transducers, pressure vessels of different sizes and thicknesses, different epoxy systems, and frequency spectrum analysis. The central conclusion is that the acoustic emission system should be operated with a relatively low frequency bandpass to avoid large propagation signal losses.

CRYOGENIC AND SUPERCONDUCTING EQUIPMENT AND DEVICES

REFER ALSO TO CITATION(S) 26533, 26539, 27636, 27640, 27641, 27642, 27643, 27645, 27651

26709 (LA—6807-PR, pp 2-33) **Cryogenics program.** May 1977. In Energy technology. Progress report, January—March 1977.

The LASL Cryogenics Group (Q-10) has the mission to investigate and apply phenomena at low temperatures for the benefit of the Laboratory's Weapon and Energy Programs. Research progress is reported on the following: (1) dc superconducting power transmission; (2) superconducting magnetic energy storage; (3) Nb_3Ge conductor development; (4) development of laser fusion targets; (5) intense neutron source T_2 distillation development; (6) tritium systems test assembly; (7) hydrogen transportation safety; (8) magnetic refrigeration; (9) superfluid agglomerate systems; and (10) high pressure research.

26710 (NP—23061) **Superconducting devices and materials. A literature survey issued quarterly, July—September 1977. Issue No. 77-03.** Olien, N.A. (comp.). (National Bureau of Standards, Boulder, Colo. (USA). Cryogenics Div.). 1977. 105p. Bureau of Standards, Cryogenic Data Center, Boulder, CO.

The bibliography contains approximately 1500 references and is arranged by subjects. A short review of the highlights of the literature on superconducting devices and materials is included. (TFD)

26711 Regulator for controlling liquid helium bath near 4.2 K. Gamble, T.D.; Goubau, W.M.; Ketchen, M.B.; Clarke, J. (Department of Physics, University of California and Materials and Molecular Research Division, Lawrence Berkeley Laboratory, Berkeley, California 94720). *Rev. Sci. Instrum.;* **49**: No. 1, 119-120(Jan 1978).

A simple regulator for stabilizing the temperature of a liquid ^{4}He bath near 4.2 K is described. The device controls the pressure of the ^{4}He gas, and achieves a stability of +- 50 μK for the hold-time of the cryostat.

PROTECTIVE STRUCTURES AND EQUIPMENT

REFER ALSO TO CITATION(S) 26356

26712 (AD-A—046061) **Study of crisis utilization of large shelter space. Final report.** Wright, M.D.; York, S.B. III; Hill, R.H.; McKnight, J.S. (Research Triangle Inst., Research Triangle Park, N.C. (USA). Applied Ecology Dept.). Aug 1977. Contract DCPA01-76-C-0318. 130p. (RTI—44U-1340). NTIS PC A07/MF A01.

This study consisted of an investigation into the options available for utilizing large, special facilities such as tunnels, government installations, and large industrial buildings for nuclear fallout shelters in CRP host areas. Technical consideration was given to the provision of lighting, ventilation, water, and sanitary systems for large groups of people. This task was accomplished by first establishing the existing availability of these services and then identifying ways of augmenting the existing services. An investigation was also made of the possibilities of suitable close-in shelter for key workers. All of the analyses were made using existing data already collected and example problems are included as an appendix.

HANDLING EQUIPMENT AND PROCEDURES

REFER ALSO TO CITATION(S) 26297

MINING AND DRILLING EQUIPMENT AND FACILITIES

26713 Seismic drill hole surface plug. Bassani, P. US Patent 4,066,125. 3 Jan 1978. Priority date 23 Dec 1976, Canada. 4p.

The invention relates to a means for use in plugging a well. The method includes a flexible plug having a series of alternating long and short fingers radiating outwards from a central area, the fingers have projections for engaging with the wall of the well and together forming a cup-shaped plug to hold concrete poured into the mouth of the well to provide a plug.

LASERS

REFER ALSO TO CITATION(S) 26658, 27064, 27533, 27676, 27678, 27680

26714 (AD-A—042229) **Theory of high intensity multimode gas lasers: inclusion of collisional effects. Final report, 15 August 1973—31 May 1977.** Berman, P.R. (New York Univ., N.Y. (USA). Dept. of Physics). 31 May 1977. 10p. (LT—1). NTIS PC A02/MF A01.

Several topics in laser theory and the interaction of radiation with matter are discussed. First, a mathematical theory of a high intensity single mode gas laser has been developed. New computational techniques have been applied which serve to unite several previous approaches to single mode laser theory. A generalized dressed atom approach was formulated to provide a new way of viewing the physical processes occurring when high intensity fields interact with matter. Second, a theoretical study of the manner in which laser sepctroscopy can be used to probe collision effects in atomic and molecular systems has been undertaken. Both two and three level systems were studied; steady state and coherent transient techniques were examined. It is now apparent that laser spectroscopy will be a useful tool for the determination of various excited state differential and total cross sections.

26715 (AD-A—042233) **Closed-cycle rare-gas electrical-discharge laser. Final report, 1 June 1973—30 September 1976.** Olson, R.A.; Grosjean, D.F. (Systems Research Labs., Inc., Dayton, Ohio (USA)). Apr 1977. Contract F33615-73-C-4130. 179p. (SRL—6792-F). NTIS PC A09/MF A01.

The recently developed technology of high-pressure molecular lasers has been combined with ultrahigh-vacuum technology to develop a fast-flow high-pressure laser system capable of long-duration closed-cycle operation with rare gases. The system has been used to investigate laser media excited by short, fast-rising high-voltage pulses under conditions of high pressure, fast flow, and low-background impurity level. Experimental results of parametric investigations of high-repetition-rate laser performance for Ar-Xe and He-Xe mixtures are given. Ultraviolet photoionization characteristics of molecular lasers are presented. The photoabsorption cross sections and photoionization yields of N,N-dimethylaniline, triethylamine, trimethylamine, and tri-n-propylamine are given and their use as laser seed compounds discussed; nitric oxide is also considered. UV emission spectra of spark sources applicable to CO and CO_2 preionized lasers are presented.

26716 (AD-A—042271) **Metal vapor visible laser kinetics program. Final technical report.** Trainor, D.; Mandl, A.; Hyman, H. (Avco-Everett Research Lab., Everett, Mass. (USA)). Dec 1976. Contract N00014-75-C-0061. 26p. NTIS PC A03/MF A01.

The objective of this program is to investigate experimentally and theoretically the important kinetic rate processes pertinent to the development of a high power metal vapor visible laser. This research consists of three tasks. Task I - Lower Level Kinetics (Experimental). The purpose of this task is to identify metal atom systems that allow selective collisional relaxation processes to efficiently quench lower levels of potential or demonstrated laser transitions. The present experimental study is directed to kinetic rate constant measurements for collisional relaxation of low-lying metastable states of lead, copper, and bismuth. TASK II - Upper level kinetics(experi-

mental) The purpose of this task is to determine the efficiency of various quenching gases in deactivating the upper laser level of lead. To be useful, a quenching gas must rapidly relax the lower laser level and slowly relax the upper laser level, i.e. be selective. The high temperature resonance fluorescence apparatus utilizing DC phase sensitive detection techniques constructed under this contract was used to provide cross-section information on the lead(6p7s) 3P 10 state. This task was completed and results reported in the semi-annual technical report dated February 1976. TASK III - excitation processes (theoretical). The objective of this effort is to calculate electronic impact and quenching cross sections for the upper and lower laser levels of copper. Important cross sections required for modeling the copper vapor laser were calculated.

26717 (AD-A—042282) **Annular iodine laser facility. Interim report.** Turner, E.B.; Chodzko, R.A.; Gross, R.W.F. (Aerospace Corp., El Segundo, Calif. (USA). Aerophysics Lab.). 15 Jun 1977. Contract F04701-76-C-0077. 44p. NTIS PC A03/MF A01.

The design and performance of an annular iodine laser built to study annular resonators at a large Fresnel number are described. A high-intensity axial flashlamp is used to dissociate C3F7I vapor in the annular lasing region. The excited iodine atoms resulting from this dissociation produce radiation of 1.315 micrometer wavelength by stimulated transition to the ground state. The pulsed energy output of 12.5 J was close to the performance estimates, which also indicated a small signal gain of 6.2 per meter, required for saturation of the medium, could be obtained. The details of the high-voltage capacitor discharge circuit, the vacuum and gas handling system, and the laser tube fabrication are described.

26718 (AD-A—042289) **Iodine laser. Master's thesis.** Halliday, W.H. (Naval Postgraduate School, Monterey, Calif. (USA)). Jun 1977. 53p. NTIS PC A04/MF A01.

There has been a project at the Naval Postgraduate School for the past two years to build a high power, short pulse, Iodine Photodissociation Laser to be used for plasma and nuclear fusion related research. The first attempt, reported previously, met with difficulties. This paper details the changes made to the previous system in order to achieve a working laser. Lasing was observed for the first time on 31 January 1977. First shot energies up to 150 milljoules have been obtained in a pulse length of 15 microseconds. Investigation was carried out on the reduction in output energy with repeated shots on the same gas filling. The rate of deterioration was shown to increase with increasing fill pressure and to be caused mainly by the formation of molecular iodine. Removal of the molecular iodine between shots significantly reduced the deterioration rate.

26719 (AD-A—042341) **Hydrogen fluoride/deuterium fluoride laser at the naval postgraduate school. Master's thesis.** Funk, W.T.; Sontheimer, R.F. (Naval Postgraduate School, Monterey, Calif. (USA)). Jun 1977. 91p. NTIS PC A05/MF A01.

A small scale hydrogen fluoride (HF) or deuterium fluoride (DF) laser was constructed for the Atmospheric Optical Propagation Program at the Naval Postgraduate School. The laser, with almost forty individually selectable wavelengths between 2.5 and 4.1 micrometers, will prove to be a valuable instrument for the continued studies of laser propagation. In the HF mode, a multiline power out of seven watts was acheived with a confocal cavity arrangement. In the single-line HF mode, fifteen separate wavelengths were distinguished. Three watts of multiline power was achieved in the DF mode while eighteen separate single-line wavelengths were obtained including 160 milliwatts at 3.8007 micrometers, the P2(8) transition. This wavelength is of particular interest to the Navy because of its excellent propagation characteristics in the marine boundary layer.

26720 (AD-A—042344) **Synthesis of the laser dyes, AC2F and AC3F, and related compounds. Research report, July—September 1976 and April—May 1977.** Henry, R.A.; Hammond, P.R. (Naval Weapons Center, China Lake, Calif. (USA)). Jun 1977. 22p. (NWC-TP—5953). NTIS PC A02/MF A01.

The synthesis of the laser dye, AC2F, which is 2-oxo-6,9-dimethyl-4-trifluoromethyl-6,7,8,9-tetrahydro-2H-pyrano(2,3-b)(1,8)naphthyridine, in nine steps from readily available starting materials is described. AC3F, which is the homologous 6,8,9-trimethyl compound, is made in six steps. Several related azacoumarins and azaquinolones, which fluoresce in the range 393-482 nm in ethanol, have also been prepared. In addition, 2-oxo-6,9-dimethyl-8-phenyl-4-trifluoromethyl-6,7,8,9-tetrahydro-2H-pyrano(2,3-b)(1,8)naphthyridine has been made from 7-hydroxy-1,4-dimethyl-2-phenyl-1,2,3,4-tetrahydro-1,8-naphthyridine and sulfonated to furnish a water-soluble fluorescer (473 nm). (Author)

26721 (AD-A—042346) **Feedback and acousto optic isolation effects on laser stability. Final report, June 1975—June 1976.** Corcoran, V.J. (Institute for Defense Analyses, Arlington, Va. (USA). Science and Technology Div.). Mar 1977. Contract DAHC15-73-C-0200. 88p. (P—1240). NTIS PC A05/MF A01.

This paper analyzes the effect of optical feedback on laser frequency stability and the acousto optic isolator concept, which was demonstrated previously. The frequency pulling effect associated with feedback of a signal at a frequency other than the oscillator frequency has been shown to require a nonlinearity such as saturation in the laser medium. The analysis mathematically corroborates the initial acousto optic isolator concept and the limited experimental data available. In the study of the acousto optic isolator, it was determined that an acceptable analytic expression for the imaginary part of the susceptibility of an unsaturated inhomogeneously broadened line, and the expression for the susceptibility of a saturated inhomogeneously broadened line, were not available. The expressions which were desired for the analysis in this paper were obtained for what is believed to be the first time. The results of this paper provide a foundation for the acousto optic isolator. Applicability of these findings should increase as coherent laser radars, which require isolation to insure accuracy of the Doppler information in the return signal, are developed.

26722 (AD-A—042458) **Temporal stability of single-line cw HF chemical laser with unstable resonator. Interim report.** Turner, E.B.; Chodzko, R.A.; Mirels, H. (Aerospace Corp., El Segundo, Calif. (USA). Aerophysics Lab.). 24 Jun 1977. Contract F04701-76-C-0077. 21p. NTIS PC A02/MF A01.

The temporal stability of the output from a single-line cw HF chemical laser with an unstable resonator was investigated experimentally to determine if large-scale output power fluctuations, associated with a 'mode-medium' instability of the type originally postulated by Dreizin and Dykhne, would be observed. Cases where the gain at the resonator inlet was less than or greater than the threshold value were studied. In all cases, the output was found to be stable. For inlet gain less than the threshold value, this result is in accord with the theoretical prediction of Mirels.

26723 (AD-A—042484) **Copper halide laser research. Final report.** Liu, C.S.; Feldman, D.W.; Pack, J.L.; Weaver, L.A. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Research and Development Center). 31 Mar 1977. Contract N00014-74-C-0445. 42p. NTIS PC A03/MF A01.

Report describes results of experimental studies of copper halide laser systems. The properties of double-pulse and multipulse copper halide laser systems have been established. Both pulser and laser tube designs have demonstrated reliable operation under high power, high prf operation: pulser lifetimes of 300 hours and laser tube lifetimes of 100 hours without failure have been recorded for self-heated, high power operation. Laser tubes of various sizes were tested for high energy per pulse operation; the results indicated that high energy operation is presently inhibited by discharge stability problems which occurred in scaled-up laser tubes, and that optimum prf for multipulse excitation does not vary with tube diameter over the range studied.

26724 (AD-A—042490) **Fiber-optic-coupled LOC injection-laser array for 8500 angstroms room-temperature emission. Final report.** Carr, D.L.; Doerbeck, F.H. (Texas Instruments, Inc., Dallas (USA)). Dec 1972. Contract DAAK02-72-C-0257. 41p. (TI—03-72-159). NTIS PC A03/MF A01.

The objective of this program was to fabricate a fiber-optic-coupled injection laser array for the wavelength of 8500 A at room temperature. The laser devices used are of the narrow-beam-angle large-optical-cavity (LOC) type. The array emitted 84 W peak optical power from an emission aperture of 15 mils by 20 mils, with a peak wavelength of 8420 A and a half-intensity beamwidth of 38 deg, when driven with pulses of 50-amps peak current, 150-ns duration, and 5-kHz repetition rate.

26725 (AD-A—042561) **Ir window studies. Final report, 1 September 1975—1 September 1976.** Marburger, J.H.; Bass, M. (University of Southern California, Los Angeles (USA). Electronic Sciences Lab.). Apr 1977. Contract F19628-76-C-0162. 101p. NTIS PC A06/MF A01.

Research concerned with several aspects of the infrared laser window problem is described. Measurements of the Hall effect and electrical conductivity were used to study defects in ZnSe and it was found that a defect model governed by ionic defects can be developed. Pulsed laser damage studies revealed that there are still significant sample to sample variations even in today's so-called improved materials.

26726 (AD-A—042671) **Temperature, stress and optical phase difference for a window transmitting a cw laser beam. Research report.** Zar, J.L. (Avco-Everett Research Lab., Everett, Mass. (USA)). Oct 1976. Contract F19628-75-C-0066. 24p. (AERL-RR—432). NTIS PC A02/MF A01.

A crystal of CVD zinc selenide was placed in the steady 2 kW beam of a 10.6 micrometer laser. The beam was approximately gaussian with 1/e radius of 0.24 cm. Fifty frame per second motion pictures were taken of the time dependent optical distortion as observed with He-Ne light and a Mach-Zehnder interferometer.

Thirty-one circular fringes originated in 10 s. A theoretical solution is derived for the heating rate, rate of development of thermoelastic stress and rate of change of optical path as a function of time, radius, and surface cooling rate. The expressions are obtained in closed form for a gaussian laser beam and presented in non-dimensional form. The theory is then compared with the experiment. For the first five seconds of heating, there is good agreement. In the next four seconds, the heating rate is higher than calculated and the discussion contains some possible explanations. (Author)

26727 (AD-A—042674) **Solid gas generators for chemical lasers.** Bowen, R.E.; Pisacane, F.J.; Barber, W.H.; Dengel, O.H.; Robb, R.A. (Naval Surface Weapons Center, Silver Spring, Md. (USA)). 1976. 16p. NTIS PC A02/MF A01.

Solid gas generator formulations which produce H_2, D_2, and a mixture of F_2 and NF_3 have been developed for HF/DF chemical lasers. NF_4BF_4 has been chosen as the oxidizer candidate for the F_2/NF_3 solid gas generator. A continuous reactor for the photolytic production of NF_4BF_4 was designed and assembled. A production rate of 5g in one hour of pure NF_4BF_4 has been achieved. The F_2/NF_3 solid gas generator formulation NF_4BF_4/KF/Sn was selected for further evaluation. Burning rates of the order of .08 cm/sec and yields of approximately 34 wt% available fluorine have been realized. Pressed pellets exhibited excellent mechanical and safety characteristics. A mixture of LiAlD4 and ND_4Cl has been selected, characterized and test fired at the 1500g level at a burning rate of 0.064 cm/sec. A point design concept for a F_2/NF_3 fuel system has been developed incorporating existing laser and gas generator technology.

26728 (AD-A—043319) **Simple model of a chain-reaction pulsed HF laser. Interim report.** Kerber, R.L.; Whittier, J.S. (Aerospace Corp., El Segundo, Calif. (USA). Aerophysics Lab.). 29 Jul 1977. Contract F04701-76-C-0077. 40p.

With economical, yet accurate, predictions of pulsed H2 + F2 laser performance as a goal, a rate equation model is formulated that includes only the dominant kinetic mechanisms in the active medium. Effects of model assumptions are examined, and predictions of pulse characteristics are compared with results from a more comprehensive model presented in an earlier study. Computing costs for the present are less than 1% of those for the comprehensive model; moreover, the present model yields laser pulse characteristics that are consistent with experiment and in excellent agreement with the more comprehensive model. In order to illustrate the model's capability, the effects of initial gas mixture composition and cavity threshold on laser performance are studied over the regime of practical interest. Some possible extensions and applications of the model are also discussed. (Author)

26729 (AD-A—043339) **Molecular and chemical laser systems. Final report, 4 February 1974—30 June 1977.** Wiesenfeld, J.R.; Wolga, G.J. (Cornell Univ., Ithaca, N.Y. (USA)). 25 Jul 1977. 5p. NTIS PC A02/MF A01.

The work performed under the above referenced grants included an experimental study of the reaction system O + HI yielding OH + I or I* and O2('delta g) + I(2P3/2) in equilibrium with O2(3 sigma 9) + I*(2P1/2) in a flow system. Measurements of optical gain at the I atom laser wavelength of 1.315 microns indicated an optical loss of 3 to 8% across the transverse flow laser channel. Parametric studies were made on a variety of compounds suitable for photodissociative pumping of I atom lasers. Spontaneous mode locking was observed and experimentally studied in a photolytically pumped I atom probe laser. Electronic to vibrational energy transfer between O2*('delta g) and HF leading to the vibrational excitation of HF to levels v=1 and v=2 was observed and studied. Evidence was provided that the transfer occurs from O2('delta g) rather than from O2('sigma +g).

26730 (AD-A—043808) **Energy transfer in lasers. Final technical report.** Fisher, E.R.; Lightman, A.J. (Wayne State Univ., Detroit, Mich. (USA). Research Inst. for Engineering Sciences). Jun 1977. Contract N00014-75-C-0284. 109p. NTIS PC A06/MF A01.

This final report details plasma-chemical and energy transfer studies carried out at the RIES. Experimental and analytical research has been aimed at understanding additive effects in discharge supported molecular laser systems, particularly the CO laser system. Extensive numerical model codes have been developed and applied to the CO system with considerable success. Experiments in the laboratories have provided important information on high lying vibrational states in CO, in agreement with model predictions. Collaborative studies between RIES and Princeton University on the behavior of vibrational distributions under strongly pumped conditions is outlined.

26731 (AD-A—043812) **Review of rate coefficients in the D_2-F_2 chemical laser system. Interim report.** Cohen, N. (Aerospace Corp., El Segundo, Calif. (USA). Aerophysics Lab.). 5 Aug 1977. Contract F04701-76-C-0077. 54p. (TR—0077(2603)-3). NTIS PC A04/MF A01.

The literature pertaining to the chemical kinetics of the deuterium-fluorine chemical laser system is critically reviewed and data are evaluated. A set of best values of all rate coefficient is recommended for modeling and computer calculations. Where experimental data are lacking, estimates are made on the basis of current theoretical techniques or data for analogous kinetic processes. (Author)

26732 (AD-A—046004) **Tunable optical sources. Final report 1 Jul 74—30 Jun 77.** Byer, R.L.; Harris, S.E. (Stanford Univ., Calif. (USA). Edward L. Ginzton Lab.). Jul 1977. Contract DAAG29-74-C-0033. 12p. (GL—2728). NTIS PC A02/MF A01.

Research briefly summarized dealt with a tunable coherent spectrometer using a Nd:YAG laser pumped LiNbO3 parametric oscillator, and the development and verification of the theory of resonantly two-photon pumped metal vapor up-converters, and the demonstration of practical devices arising from the theory.

26733 (AD-A—046014) **Fundamental kinetic rate processes occurring in polyatomic vibrational lasers. Final technical report 11 Nov 76—11 Jun 77.** Leone, S.R. (Joint Inst. for Lab. Astrophysics, Boulder, Colo. (USA)). Aug 1977. Contract F19628-77-C-0034. 15p. NTIS PC A02/MF A01.

Laboratory experiments have been performed to study gaseous systems with regard to understanding electronic-to-vibrational energy transfer and chemical reactions of neutrals and ions which yield product state vibrational excitations. These results are important for the development of new methods to pump infrared vibrational lasers by energy transfer and by chemical reaction mechanisms. In addition, many chemical reaction systems are responsible for infrared emissions which are observed in the upper atmosphere under normal and perturbed conditions. Of utmost significance has been the development of a new experimental method to observe for the first time infrared vibrational chemiluminescence from ion-molecule reactions. This technique offers promise for numerous detailed studies of the dynamics and infrared emission of ion-molecule reactions.

26734 (AD-B—009019) **K-RB laser pump lamp. Final technical report Nov 73—Feb 75.** Anderson, N.C. (ILC Technology, Inc., Sunnyvale, Calif. (USA)). Nov 1975. Contract F33615-74-C-1027. 88p. (R-ILC—73-30/F). NTIS PC A05/MF A01.

A program was conducted to continue development of a potassium-rubidium arc lamp for laser pumping. Significant progress was made. Improved lamp bake-out, improved filling procedures and incorporation of an internal uranium getter prevented attack of the polished sapphire lamp envelope by the potassium vapor. A new, single envelope, air compatible lamp with nickel endcaps and novel brazed endseals was successfully tested. Dramatic improvement in laser pumping efficiency was achieved by substituting xenon starting gas for argon. Difficulties were encountered in fabricating an alternative lamp with double endcaps (protected end seals). This prompted a development effort to improve joining technology for this lamp. Encouraging results were obtained with a fused silicide oxidation protective coating for niobium endcap lamps. The best life test result on nickel endcap lamps was 85 operating cycles and 464 hours. Work is continuing on a subsequent contract.

26735 (AD-B—015785) **C. W. GaAs diode laser. Final report 1 Dec 73—2 Dec 74.** Dierschke, E.G. (Texas Instruments, Inc., Dallas (USA)). Dec 1975. Contract F33615-74-C-1006. 97p. (TI—03-75-26). NTIS PC A05/MF A01.

Techniques for improving the performance of cw laser diodes at 77°K were investigated. Work concentrated on the single heterostructure laser. The liquid-phase epitaxial growth procedure, the doping concentrations, and the active recombination region thickness were optimized to achieve low threshold currents high slope efficiencies, and narrow emission beams. A double-sided copper heat sink design incorporating intermediate submounts was used. The submounts were used for improved control during mounting of the laser and to reduce thermal resistance by use of high thermal conductivity materials. A suitable assembly process was established after the solution of various problems.

26736 (BDX—613-1907) **Universal monitor for CO_2 lasers.** Wonnell, L.D. (Bendix Corp., Kansas City, Mo. (USA)). 1977. Contract EY-76-C-04-0613. 14p. (CONF-771040—9). Dep. NTIS, PC A02/MF A01.

From Electro-Optical systems conference; Anaheim, CA, USA (25 Oct 1977).

A system has been developed for characterizing the profile, average power, and pulse shape of a CO_2 laser beam. The design includes an integrating sphere, a pyroelectric detector, interchangeable chopper-wheel attenuators, and relatively simple circuitry that can be expanded to accommodate inputs in excess of 10 kW. The profile of the entire beam is rapidly scanned and displayed in a three-dimensional oscilloscope pattern. Average power is determined by a synchronous rectifier and is read with a digital voltmeter. The pulse shape is monitored by the use of conventional oscilloscope tech-

niques. This system greatly simplifies the on-site calibration of CO_2 lasers in factory areas.

26737 (LA-UR—77-328) **Performance characteristic of discharge excited excimer lasers.** Sze, R.C.; Scott, P.B.; Loree, T.R. (Los Alamos Scientific Lab., N.Mex. (USA)). 1977. Contract W-7405-ENG-36. 12p. (CONF-770256—1). Dep. NTIS, PC A02/MF A01.

From 2. winter colloquium on laser induced chemistry; Park City, UT, USA (13 Feb 1977).

The design and operating parameters of a 1/4 J large volume KrF discharge laser are given. (TFD)

26738 (NTIS/PS—77/0709) **Carbon dioxide lasers. Volume 2. 1975—May 1976 (a bibliography with abstracts). Report for 1975—May 1976.** Smith, M.F. (National Technical Information Service, Springfield, Va. (USA)). Aug 1977. 202p. NTIS PC N01/MF N01.

The design, construction, operation and performance of CO2 lasers are cited. Topics relating to excitation, optical pumping, light pulses, infrared optical materials, mirrors, frequency tuning, gas dynamics, chemical reactions, thermal blooming and atmospheric transmissivity are included. Foreign translations and reports not available from NTIS are excluded. (This updated bibliography contains 197 abstracts, none of which are new entries to the previous edition.) See also NTIS/PS-75/473, Carbon Dioxide Lasers. Vol. 1. 1970-1974.

26739 (NTIS/PS—77/0710) **Carbon dioxide lasers. Volume 3. June 1976—August 1977 (a bibliography with abstracts). Report for June 1976—August 1977.** Smith, M.F. (National Technical Information Service, Springfield, Va. (USA)). Aug 1977. 149p. NTIS PC N01/MF N01.

Citations on theory, design operation, output and diagnostics of CO2 lasers are presented. Studies relating to excitation, frequency conversion, modulation, laser pumping, reaction kinetics, gas dynamics, and plasmas are included. The development and efficiency of optical components such as mirrors, resonators, tuning devices, infrared optical materials, amplifers, and gratings are also discussed. (This updated bibliography contains 144 abstracts, all of which are new entries to the previous edition.) See also NTIS/PS-75/473, Carbon Dioxide Lasers. Vol. 1. 1970-1974 and NTIS/PS-77/0709, Carbon Dioxide Lasers. Vol. 2. June, 1976-August, 1977.

26740 (RLO/2230/T4—191) **Opportunities to produce coherent soft x-rays at Stanford.** Csonka, P.L. (Stanford Linear Accelerator Center, Calif. (USA); Oregon Univ., Eugene (USA). Inst. of Theoretical Science). Feb 1977. Contract EY-76-S-06-2230-004. 29p. Dep. NTIS, PC A03/MF A01.

The suitability of synchrotron radiation to pump x-ray lasers, is discussed. A method is suggested to produce lambda = 135 A coherent soft x-ray radiation from 2p → 1s transitions in a Li III gas, or lambda approximately 60 A radiation from Be III gas by pumping with synchrotron radiation. It is compared to an earlier proposed method, according to which lambda = 206 A coherent photons would be emitted from 2p → 1s transition in Li II. Not only does the here suggested method produce shorter wavelength radiation than the earlier method, but, surprisingly, it requires almost an order of magnitude fewer pumping x-ray photons to reach the lasing threshold for Li III. This needed pumping synchrotron radiation intensity is about on order of magnitude higher (for Li III) than what SSRP (Stanford Synchrotron Radiation Project) now produces when the circulating electron energy, E/sub e/ = 3 GeV in a 2 mrad beam during normal operation, and is orders of magnitude less than what can be produced by a wiggler magnet in SPEAR. For the Be III laser, the required intensity is much higher than for the Li III laser, but might still be reached with a wiggler magnet in SPEAR when E/sub e/ = 3 GeV. If E/sub e/ = 0.55 GeV can be achieved in SPEAR, then a very simple wiggler magnet placed in one of its low beta sections could produce enough radiation to operate the Li III laser. A sophisticated wiggler in the same location could drive the Be III laser. Assuming that PEP is built as now planned, a bending magnet in one of its low beta sections would produce enough photons to reach the lasing threshold for Li III; with a wiggler magnet there, a Be III laser could also be operated.

26741 (RLO/2230/T5—192) **Possibility of coherent hard x-ray production by pumping with synchrotron radiation and low energy photons. Period covered: November 17, 1976—August 16, 1977.** Csonka, P.L. (Oregon Univ., Eugene (USA)). 1977. Contract EY-76-S-06-2230-004. 26p. Dep. NTIS, PC A03/MF A01.

Coherent x-rays in the keV range could be produced by pumping a suitable gas with synchrotron radiation in combination with low energy photon beams in the presence of appropriately arranged mirrors. With a wiggler magnet placed in the low beta section of the PEP machine to be constructed at Stanford, 1020 eV coherent photons could be produced from Ne. Appropriate synchrotron radiation will produce a highly ionized cool gas. Low energy photons modify the outer electron structure of ions to enhance lasing: they modify the lifetime of the inverted state, counterbalance unwanted collisionally induced transitions, reduce Stark line broadening.

26742 1.05 to 1.44 μm tunability and performance of the cw Nd^{3+}:YAG laser. Marling, J. (Univ. of California, Livermore). *IEEE J. Quant. Electron.;* **QE-14**: No. 1, 56-62(Jan 1978).

The Nd^{3+}:YAG laser pumped by a cw 5-kW krypton arc-lamp was tuned to 19 different transitions from 1.052 to 1.444 μm by means of intracavity thin solid etalons and appropriately coated resonator mirrors. Each transition was tunable over 6 to 12 wavenumbers and most exhibited 10 to 30-W cw output, attaining 37 W at 1.319 μm and 52 W at 1.112 μm. The 1.061-μm line is 90% as strong as at 1.064 μm, and wavelength shift with temperature variation was measured for both. TEM_{00} output of 20 w was available by using apertures, and compensation of thermal lensing resulted in 60 W combined TEM_{00} + TEM_{01} output.

26743 Injection-locked, narrow-band KrF discharge laser using an unstable resonator cavity. Goldhar, J.; Murray, J.R. (Lawrence Livermore Laboratory, University of California, Livermore, California 94550). *Opt. Lett.;* **1**: No. 6, 199-201(Dec 1977).

A low-energy etalon-tuned KrF discharge laser is used as a source to injection lock a 70-mJ KrF unstable resonator oscillator in a very simple configuration. Operating parameters and synchronization are discussed. Degradation of KrF discharge laser output with time is also studied and inferred to be partly a result of absorption at 248—249 nm by CF_2 formed in the discharge.

26744 Experimental study of an electrical discharge laser with supersonic gas flow in a magnetic field. Ivanov, R.S.; Karpukhin, V.T.; Korolev, N.M.; Malikov, M.M.; Nedospasov, A.V.; Stotskii, G.I. (High-Temperature Institute, Academy of Sciences of the USSR). *High Temp. (USSR) (Engl. Transl.);* **15**: No. 3, 526-532(Nov 1977).

Results are presented from a study of a laser using a mixture of helium, carbon dioxide, and xenon pumped through crossed electric and magnetic fields at a supersonic velocity. The effective Hall parameter, the conductivity, and the plasma electron temperature and density were measured. The laser output is found to depend strongly on the magnetic field.

26745 Hypersonic gas laser. Fenneman, D.B. US Patent 4,042,892. 16 Aug 1977. Filed date 22 Jul 1976. 5p.

A hypersonic gas laser is presented, which produces coherent infrared radiation for use in communication, illumination, energy transmission or weather control. The lasing device uses an interaction area consisting of a grid of fine wires or the like to convert the kinetic energy of hypersonic velocity gases to vibrationally excited nitrogen from which the laser energy is extracted.

26746 Modulation spectroscopy of He—Ne laser levels. Tuchin, V.V.; Knyazevskaya, G.S. *Opt. Spectrosc. (USSR) (Engl. Transl.);* **43**: No. 2, 171-176(Aug 1977).

An analysis is performed of the efficiency of modulating the population inversion density of an He—Ne gas laser when the discharge current is excited at frequencies comparable to the reciprocal times for establishment of the main relaxation processes in the gas discharge plasma. On the basis of this analysis, a modulation method is developed for determining the lifetime of atoms in the metastable states responsible for the creation and destruction of the inversion. Prospects for applying the method to the study of capillary laser plasmas are discussed.

26747 Competition of oppositely traveling waves in a single-isotope ring laser with anisotropic cavity. Birman, A.Y.; Savushkin, A.F.; Tropkin, E.N. *Opt. Spectrosc. (USSR) (Engl. Transl.);* **43**: No. 2, 184-187(Aug 1977).

The effect of the polarization characteristics of oppositely traveling waves of a single-isotope ring laser on the stability of single wave lasing regimes is examined. A detailed analysis is made of the character of lasing in the region of competition in the case when the oppositely traveling waves have weak elliptical polarization. It is shown that wave competition is determined to a large extent by the correlation between the signs of ellipticity which characterize the direction of rotation of the electric field vector.

26748 Correspondence between the calculated and experimental generated power of flashtube-pumped rhodamine lasers. Aristov, A.V.; Kozlovskii, D.A.; Levin, M.B.; Cherkasov, A.S. *Opt. Spectrosc. (USSR) (Engl. Transl.);* **43**: No. 1, 65-68(Jul 1977).

A comparison is given of the generated quantum power of a laser using standard solutions of several rhodamine dyes with its calculated values when the pumping energy, cell diameter, distance between the resonator mirrors, reflectance of the exit mirror, fluorescence quantum yield, and harmful loss factor are varied. The experimental conditions under which a quantitative correspondence between these values is observed have been determined.

26749 Concerning the problem of lasers for the far ultraviolet λ~500—700 A. Ilyukhin, A.A.; Peregudov, G.V.; Ragozin, E.N.;

Sobel'man, I.I.; Chirkov, V.A. (P. N. Lebedev Physics Institute, USSR Academy of Sciences). *JETP Lett. (USSR) (Engl. Transl.);* **25**: No. 12, 535-539(20 Jun 1977).

Results are reported of experimental investigations aimed at obtaining lasing in the far ultraviolet region of the spectrum ($\lambda \sim 600$ A on the transitions $2p^5 3p$—$2p^5 3s$ of the neon-like ion Ca XI) in a plasma produced by laser heating of a calcium target.

26750 Pulsed electrical-discharge CO_2 laser with ionization of the gas mixture by ultraviolet radiation at atmospheric pressure. Zakharov, A.S.; Zelenov, A.A.; Semenov, E.P.; Yudintsev, E.M. *Sov. J. Opt. Technol. (Engl. Transl.);* **44**: No. 6, 343-345(Jun 1977).

This paper describes a CO_2 laser with a non-independent transverse discharge in a CO_2—N_2—He gas mixture, maintained by ultraviolet radiation, the source of which is located near the grid electrode, so that the UV radiation energy is utilized most effectively and a lasing energy of 40 J is provided in a mode volume of ~ 2000 cm^3. It is shown that varying the on-time of the UV source makes it possible to vary the duration of the lasing within limits from 7 to 30 μsec.

26751 Influence of resonant properties of the discharge of He—Ne laser emission. Zabortseva, T.A.; Levchenko, A.S.; Ostapchenko, E.P.; Stepanov, V.A. *Radiotekh. Elektron.;* **22**: No. 6, 1300-1302(Jun 1977). (In Russian).

The results of studies of the influence that current modulation in the frequency band up to 1 MHz has on the behavior of the output power of He-Ne laser emission in different modes of operation are presented. A diagram of the experimental setup is given.

26752 Differential electro-optical shutter. Gusev, M.E.; Novikov, M.A. *Radiotekh. Elektron.;* **22**: No. 6, 1258-1262(Jun 1977). (In Russian).

An optical shutter for Q-switched lasers is proposed in which the modulation factor of the output emission is determined by the time derivative of the modulating signal rather than by its amplitude. The working principle of this shutter automatically precludes the influence of natural birefringence and thus extends the range of possible crystals that can be used. In addition, the proposed shutter can utilize the transverse electro-optical effect, which reduces the required control voltage. Although the proposed element can use Faraday and Kerr cells, only Pockels cells are considered as modulating elements. An arrangement is described in which the shutter is used for pulse chopping in a Q-switched ruby laser. The electric pulse is shaped by a laser discharger. The proposed shutter can be used to produce optical pulses of nanosecond and sub-nanosecond duration. The shape and duration of the output pulses can be varied over a wide range of simply shifting the reflecting mirror rather than by varying the shape and amplitude of the control voltage as in conventional shutters. When used as one of the mirrors in the laser cavity, the shutter could be very convenient for emission of isolated picosecond pulses in the case of mode-locked lasers.

26753 Free expansion nozzle for gas dynamic lasers. Braunschweig, E.D.; Wilson, R.E. US Patent 4,021,753. 3 May 1977. Filed date 8 Apr 1975. 5p.

A free expansion nozzle is described for gas dynamic lasers, having a multitude of finely divided free expansion sites. These sites may be in the form of a plurality of minute openings within a plate, or minute spacings between adjacent cylinders, or in the form of a small mesh screen. These expansion sites may be situated within the nozzle section of a gas dynamic laser, thereby providing an easily fabricated, economical means of producing a lasing medium within the optical cavity of the laser.

26754 Effect of discharge buildup in flash lamps on the efficiency of laser pumping. Basov, Yu.G.; Morozova, S.G.; Tokareva, A.N. *Radiotekh. Elektron.;* **22**: No. 5, 1014-1022(May 1977). (In Russian).

A study was made concerning the discharge buildup in model IFP-800 flash lamps placed inside or outside laser luminaires, and concerning the effect of discharge anomalies on the laser efficiency. In the first part of the experiment, discharges were photographed with a model SFR-2M camera in the continuous-sweep mode, cylindrical luminaires of various sizes and with various reflection coefficients were used, and the parameters of discharge dynamics were measured at two different power densities (50 and 250 kW/cm^3). In the second part of the experiment the efficiency of a laser on yttrium-aluminum garnet with neodymium was measured, with dielectric reflectors deposited on both bases of the crystal, and with the cylindrical luminaire having either a specular reflector (silver foil) or a diffuse reflector (sintered SiO_2). The test results indicate that a shift of the lamp away from the reflector axis, in the case of a specular reflector, results in an asymmetric discharge and, consequently, a lower laser efficiency. In order to ensure a high laser efficiency, it is necessary that discharge in the flash lamp build up and proceed uniformly. The metallic case of the laser head should be used as the ingiter electrode but, instead, the latter should be placed directly on the lamp.

26755 Use of metal-oxide-metal diode for multiplying and mixing laser frequencies within the near infrared and the visible range. Dolgopolov, S.G.; Klement'ev, V.M.; Kovalevskii, V.I.; Matyugin, Yu.A. *Radiotekh. Elektron.;* **22**: No. 5, 1054-1056(May 1977). (In Russian).

A high-speed MOM diode, with a lag time of the order of 10^{-15} sc and with a nonlinearity probably caused by the tunneling effect, was used for extracting the third harmonic of the CO_2-laser frequency and for mixing it with the frequency of an He-Ne laser (lambda = 3.39 μm). This diode, consisting of the tungsten whisker in contact with a polished nickel cathode, was also used for detecting radiation at 1.15 and 0.63 μm wavelengths. The tungsten wire, 0.2 mm long and 6 μm in diameter, has been electrochemically etched down to a diameter smaller than the incident wavelength so as to made an effective antenna. The results of the experiment indicate the suitability of such a diode, contingent upon further improvements in the recording apparatus, as a mixer for use in the near infrared and optical range of wavelengths.

26756 Picosecond source of coherent optical radiation tunable over the 350 to 680 nm range of wavelengths. Gyuzalyan, R.N.; Sarisyan, D.G.; Ter-Mikaelyan, M.L. (Inst. of Physical Research, Ashtarak, USSR). *Kvantovaya Elektron. (Moscow);* **4**: No. 5, 1138-1140(May 1977). (In Russian).

A new picosecond laser has been developed which is tunable over the 350 to 680 nm range of wavelengths. A line continuously tunable over this range was found in the spectrum of a $LiIO_3$ nonlinear crystal pumped from a picosecond neodymium laser at the wavelength lambda = 1.06 μm. It has been shown to result from a simple shift, by the crystal, of one frequency in the continuous spectrum of this laser which the latter produces in the crystal. A spectrogram of the tunable radiation is shown, with the second harmonic (lambda = 530 nm) at the center. The wavelength has also been plotted as a function of the crystal orientation angle, i.e., the angle between its optical Z-axis, and the direction of the lambda = 1.06 μm beam. As this angle increases from 24 to 51°, the wavelength of the tunable radiation decreases from 680 to 350 nm.

26757 Laser as a means of transferring a standard frequency into the submillimeter range. Domnin, Yu.S.; Tatarenkov, V.M.; Shumyatskii, P.A. (All-Union Scientific Research Inst. of Physicotechnical and Radiotechnical Measurements, Moscow). *Kvantovaya Elektron. (Moscow);* **4**: No. 5, 1158-1160(May 1977). (In Russian).

An HCN-laser has been developed which duplicates the 890,760 MHz frequency with the precision of a standard. It operates on the principle of automatic frequency and phase tuning against a standard signal with an accuracy of the order of 10^{-11}. When the laser frequency is measured by beating it with a harmonic of a centimeter- or millimeter-wave klystron, then the laser spectrum is much narrower than the spectrum of the standard signal multiplied to the same frequency. The laser thus has a higher momentary stability and can also be used as a source of the reference signal for stabilizing the frequency of a 4-mm wave klystron. The klystron requires a wideband automatic phase tuning for suppressing ambient 50-Hz fluctuations. The automatic phase tuning of the laser serves as the narrow-band filter. The laser-stabilized 4-mm wave klystron is now phase-locked with a 3-mm wave klystron. The resulting laser-klystron (74,232.5 MHz) to klystron (8,247.5 MHz) system has a high momentary stability and its narrow-band (a few Hz) automatic phase tuning against the standard signal is thus possible. The laser frequency is controlled by a movable resonator mirror.

26758 Laser based on yttrium—aluminum garnet with neodymium for generating a high-power fourth harmonic in the periodic pulse mode. Abakumov, G.A.; Bagdasarov, Kh.S.; Vetrov, V.V.; Vorob'ev, S.A.; Zakharov, V.P.; Pikel'ni, V.F.; Simonov, A.P.; Fadeev, V.V.; Fedorov, E.A. (Physicochemical Inst., Moscow). *Kvantovaya Elektron. (Moscow);* **4**: No. 5, 1152-1153(May 1977). (In Russian).

The feasibility is demonstrated of fabricating a laser based on yttrium-aluminum garnet with neodymium which will generate high-power radiation at its fundamental as well as second-, third-, and fourth-harmonic wavelengths (1064, 532, 355, and 266 nm respectively) with a pulse repetition rate equal to 20 Hz. This laser consists of an optoelectronic modulator, a first diaphragm, an oscillator, a second diaphragm, a resonator mirror, a telescope (a concavoconcave lens plus a convexoconvex lens), an amplifier, a second-harmonic oscillator, a fourth-harmonic oscillator, and a dispersing filter (quartz prism). All components are series manufactured, and so are all components of the pumping system. The maximum energy of a fourth-harmonic pulse at the filter output is about 35 mJ, its peak power is about 5 MW (half-width of the pulse 7 ns) and its maximum average power is about 0.7 W.

26759 Explosively driven laser amplifier system. Pilloff, H.S. US Patent 4,016,500. 5 Apr 1977. Filed date 17 Oct 1975. 4p.

A system is described for optically coupling an intense photon output from an explosively shock-heated gas, to a laser amplifier for the generation of a very high power optical pulse. A laser amplifier

element, preferably a dye laser type, is centrally located within, and supported by, an enclosed hexahedron housing filled with a visible or infrared absorbing solution. Each leg of the hexahedron has secured thereto a pyramidal shaped (a pyramid with the apex end cut off parallel with the base) gas filled lamp for pumping the laser amplifier element. Each gas lamp is provided with a liner of explosive material along the inside of the outermost surface which is ignited by an electrical detonator. Detonation of the explosive liner produces an imploding shock wave which raises the argon gas to incandescence to excite the liquid dye laser amplifier to produce a population inversion necessary for laser amplification.

26760 Single-frequency garnet laser with a waveguide resonator. Glushchenko, N.F.; D'yachenko, V.V.; Mikaelyan, A.L.; Tsarev, P.P. *Kvantovaya Elektron. (Moscow);* **4**: No. 4, 783-786(Apr 1977). (In Russian).

An experimental study was made to verify that waveguide resonators eliminate the effects of thermo-optical distortion within the active medium of solid-state lasers and thus contribute to the high coherence of the laser beam. A garnet specimen 5x5x90 mm large was placed inside a Fabry-Perot resonator and then inside a waveguide resonator, with the pumping power varied up to the breakdown level. Interference and polarization measurements have revealed that in a waveguide resonator such a laser operates in a single-frequency mode of generation, regardless as to whether or not thermo-optical distortions are averaged in one or two planes and up to pumping levels causing crystal fracture (7.0 kW). Such a laser also operates in a single transverse mode at pumping levels up to 5.0 kW, corresponding to 30 kW output power with the use of plane mirrors.

26761 Self-modulation of lasers by means of nonlinear absorbing filters. Bulgakov, B.M.; Bykov, M.M.; Ol'khovskii, I.P;. *Radio Eng. Electron. Phys. (USSR) (Engl. Transl.);* **22**: No. 1, 87-94(Jan 1977).

Translated from Radiotekh. Elektron.; 22: No. 1, 126-134(Jan 1977).

Results of a study of a carbon dioxide laser with a nonlinear absorbing filter are presented. A mathematical model of the system is formulated, and the nonlinear differential equations are analyzed. The stable states of the system and the operating conditions were examined as a function of the choice of parameters. The self-modulation mode of operation is also investigated, and the possibility of controlling the shape and repetition frequency of the radiation pulses in the self-modulation mode of operation is demonstrated.

26762 Operation of a traveling-wave laser with periodically varying cavity parameters. Fast rotation. Khoshev, I.M. *Radio Eng. Electron. Phys. (USSR) (Engl. Transl.);* **22**: No. 1, 94-99(Jan 1977).

Translated from Radiotekh. Elektron.; 22: No. 1, 135-140(Jan 1977).

The averaging method is used to carry out a theoretical analysis of the operation of a traveling-wave laser with periodic modulation of the difference in cavity frequencies and the coupling coefficients of the opposite waves in the case of large values of the DC component of the cavity frequency difference. The form of the frequency characteristic is analyzed, and simple expressions are obtained for the parametric locking zones.

26763 Analysis of continuous electron gun pre-ionized electric laser discharges. Sutter, L.V. Jr. Los Angeles; Univ. of California (1977). 149p. University Microfilms Order No. 77-19,646.

Thesis (Ph. D.).

A methodology is presented for use in the analysis of continuous electron gun pre-ionized laser electric discharges. The methodology is applicable to a number of various laser gases but the specific gas analyzed is the CO_2:N_2:He mix. Currently available data concerning electron pumping efficiencies, electron drift velocities, recombination coefficients, attachment coefficients, ionization coefficients, relaxation rates, and optical cross-sections for various CO_2:N_2:He mixes are presented. A two temperature laser kinetics model is developed for the CO_2:N_2:He laser system based on currently available V-V and V-T vibrational rate data. The two temperature laser kinetics model is coupled to the one-dimensional ideal gas-dynamic relations and to the gas discharge kinetics relations through the use of a computer algorithm. Experimental density and gain measurements are presented from data taken on a large bore continuous electric laser discharge using a 5:4:1 (He:N_2:CO_2) gas medium. The experimental setup and techniques involved in making these measurements are described. The results of these measurements are compared to the predictions of the computer algorithm. Good agreement between the computer algorithm and the experimental data is shown.Techniques in building large bore electric discharge lasers are also reviewed. Current problems based on the preceding analysis and future improvements in these devices are discussed.

26764 Electromagnetic modes of heterojunction injection lasers. Wang, C.S. Dallas; Southern Methodist Univ. (1977). 168p. University Microfilms Order No. 77-18,608.

Thesis (Ph. D.).

The theoretical modeling of heterojunction injection lasers is discussed. Studies were made on two dimensional radiation patterns, mode reflectivities due to cleved facets, transverse mode selection, and the relationships between the threshold gain and aluminum concentration of various grown layers in the GaAs-AlGaAs device structure. Two dimensional mode confinement is discussed for several laser structures including stripe geometry devices. Radiation patterns and mode reflectivities were calculated using the two dimensional model. Transverse mode selection due to a thin film coating on the laser facet is discussed. The threshold behavior for cw operation is investigated. The aluminum mole fraction in the active region determining the lasing wavelength, affects the active region gain at threshold. Lasers with a given active region width and index step have the smallest threshold gain when aluminum fraction of the active region is the largest; the peak fractional value of aluminum cannot exceed 0.37.

26765 Numerical method for two-dimensional steady-state chemical laser calculations. Ramshaw, J.D.; Mjolsness, R.C.; Farmer, O.A. (Los Alamos Scientific Lab., NM). *J. Quant. Spectrosc. Radiat. Transfer;* **17**: 149-164(1977).

A numerical method is presented for calculating the steady-state output power and other operating characteristics of a continuous flow chemical laser. The method is based upon a generalization of Emanuel's radiation-transport-theory description of a chemical laser to the case of a fully two-dimensional flow field. The steady state solution is achieved by means of a time-like iterative procedure which represents the transient the system would undergo if the radiative time scale were so slow as to be comparable to the fluid dynamical and chemical rate timescales. The method may be used in conjunction with any two-dimensional time-marching multicomponent reactive fluid dynamics computer code. Results of a typical calculation using the RICE code are presented. A prescription is given for obtaining an approximate steady-state lasing solution directly from the results of a steady-state calculation without lasing.

26766 Dye-based laser with high directionality of radiation. Zabiyakin, Yu.E. *Opt.-Mekh. Prom-st.;* No. 12, 23-25(Dec 1976). (In Russian).

In spite of their many advantages (abundance of generating substances, broad range of radiation wavelengths, variety of excitation methods and ability to operate in the pulsed or continuous mode), dye-based lasers, utilizing complex organic molecules, have failed to reach the level of certain other types of lasers in such important parameters as efficiency and beam angle divergence. This work compares the solid angle characteristics of the radiation of dye solution lasers with lamp pumping using cylindrical and coaxial dye containers. The experimental results indicate that the use of coaxial containers with a thin cylindrical dye layer can significantly improve the beam divergence characteristics of the radiation generated.

26767 Physics of semiconductors. Fumi, F.G. (ed.). New York; Elsevier/North-Holland Inc. (1976). 1351p. (CONF-760860—).

From 13. international conference on physics of semiconductors; Rome, Italy (30 Aug 1976).

Two hundred ninety-four papers were presented at the conference. Separate abstracts were prepared for five of the papers. One paper was abstracted previously for the DOE Data Base. (TFD)

26768 Recent advances in heterojunction lasers. Kressel, H. (RCA Labs., Princeton, NJ). pp 91-96 of Physics of semiconductors. Fumi, F.G. (ed.). New York; Elsevier/North-Holland Inc. (1976).

From 13. international conference on physics of semiconductors; Rome, Italy (30 Aug 1976).

See CONF-760860—.

A review is presented of heterojunction lasers, including comparisons of theory and experiment of key parameters, and materials considerations. (TFD)

26769 Chemical hf laser operating at high pressure of the active medium. Khapov, Yu.I. *Aerofiz. Issled.;* No. 5, 64-65(1975). (In Russian).

Preliminary results of investigating the chemical laser on a mixture of H_2 + SF_6 with a density of the inserted energy up to 0.1 J/cm^3, which significantly exceeds the amount of the inserted specific energy existing in the experiments of other investigators are reported. Initiation of the chemical reaction was done by an electronic beam across the optical axis. The energy of the electrons did not exceed 150 keV with a beam energy up to 16 J. The experiments were conducted in a pressure range from 0.1 to 2 technical atmospheres with H_2 : SF_6 ratios from 1 : 30 to 1 : 2. The laser operated with one mirror. A series of dependences of the energy of emission on the pressure of the active medium with H_2 : SF_6 ratios equal to 1 : 23, 1 : 8 and 1 : 2 was obtained. It was shown that with increase in pressure the energy of emission increases reaches a maximum value, and then drops. It was established that the maximum energy of emission was observed with H_2SF_6 ratios from 1 : 6 to 1 : 15. With a smaller amount of H_2 the energy of the laser decreases because of its lack (the probability of interaction of the F with the H_2 is de-

creased); with high partial pressure the rate of the collision deactivation is increased, which also leads to a decrease in output energy. It was found that with increase in the energy inserted per unit of volume of the active medium, the efficiency of the laser grows, the amount of which in these experiments reached 11%.

HEAT TRANSFER AND FLUID FLOW

REFER ALSO TO CITATION(S) 25768, 26348

26770 (UCID—17715) **SIMPLE code.** Crowley, W.P.; Hendrickson, C.P.; Rudy, T.E. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 1 Feb 1978. Contract W-7405-ENG-48. 36p. Dep. NTIS, PC A03/MF A01.

A realistic introduction to computational fluid dynamics and heat flow is provided. To do this, a two dimensional Langrangian formulation of the equations of inviscid compressible hydrodynamics and simple heat conduction is considered. A tabular ideal gas equation of state is provided for determination of the relations between the state variables. The equations of hydrodynamics and heat conduction are solved by finite difference methods. Each physical process is treated in a separate section with the physical equations stated and the difference equations derived. The computer program associated with the differential and difference equations described has been given the name SIMPLE.

26771 Calculation of two-phase critical flow using the model of disperse: annular flow. Ivandaev, A.I.; Nigmatulin, V.I. (Institute of Mechanics, Moscow State University). *High Temp. (USSR) (Engl. Transl.);* **15**: No. 3, 478-484(Nov 1977).

The use of the model of disperse: annular flow with an effective monodisperse core [1] to calculate the maximum (critical) flow rates of vapor—liquid mixtures through long tubes is discussed. The possibility of generalizing the experimental data in the literature is considered. The effect of the main determining parameters: the rate of evaporation, the drop diameter at breakaway from the film surface, and the initial drop diameter at the tube inlet: on the development from the film surface, and the initial drop diameter at the tube inlet: on the development of critical conditions at the outlet cross section is investigated. The corresponding constants of the model are determined. Experimental data are analyzed. It is established that in the investigated range of parameters the calculated and experimental values of the critical flow rate and pressure profile along the channel are in satisfactory agreement. The discrepancy between the calculated and experimental value of the critical pressure and vapor content may be due to inadequate accuracy of the experimental procedure for determining these quantities.

26772 Analysis of nonsteady flows with phase conversions. Deich, M.E.; Saltanov, G.A.; Kukushkin, A.N. (Moscow Power Institute). *High Temp. (USSR) (Engl. Transl.);* **15**: No. 3, 484-490(Nov 1977).

The frequency characteristics of nonsteady flow regimes associated with spontaneous moisture formation in Laval nozzles are investigated experimentally. Similarity theory is used to obtain the dependence of the dimensionless frequency of the nonsteady process on the Mach number in the zone of spontaneous condensation: $Sh=0.35\sqrt{1-[4.85(M/sub\ c/-1)]^2}$. This dependence can be used to determine the design frequency of the nonsteady process in condensation flow from the known duct geometry and stagnation parameters at nozzle entry.

26773 Critical conditions with unsteady-state outflow of a two-phase medium with a pipeline break. Rassokhin, N.G.; Kuzevanov, V.S.; Tsiklauri, G.V.; Marinchek, Z.; Sella, J. (Moscow Power Institute). *High Temp. (USSR) (Engl. Transl.);* **15**: No. 3, 491-497(Nov 1977).

An investigation was made of the unsteady-state outflow of a two-phase medium with a pipeline break. The experiments were made with a pressure of p=32 bar in a tube with a diameter of 102.3 mm and a length of 3 mm. During the process of evacuation, the pressure and the temperature were recorded in four cross sections along the length of the tube. An analysis is made of the heating of a liquid, which, under the conditions of the experiments, attained 14°C, and of the dynamics of the change in the parameters. A comparison is made with quasi-steady-state methods of calculation. A theoretical analysis of unsteady-state out-flow is made on the basis of an equilibrium model of a two-phase medium. A numerical solution of the difference equations was carried out along the characteristic directions using the Godunov method of layers. A comparison of the results of the calculation with experimental data gives satisfactory agreement during the main period of the process of unsealing.

26774 Propagation speeds for perturbations in a flow of a two-phase mixture. Radovskii, I.S. (Moscow Physics Research Institute). *High Temp. (USSR) (Engl. Transl.);* **15**: No. 2, 300-302(Sep 1977).

A study has been made of the nature of the perturbation that determines whether a two-phase flow is subsonic or supersonic type, type, since the speed of sound in such a medium is frequency-dependent. Expressions are derived for the speeds of propagation for perturbations of arbitrary form in a slightly nonequilibrium adiabatic two-phase flow. It is found that the form of the perturbation influences the speed considerably.

MATERIALS TESTING

REFER ALSO TO CITATION(S) 26708

VACUUM ENGINEERING

REFER ALSO TO CITATION(S) 26815

ELECTRONIC CIRCUITS AND DEVICES

REFER ALSO TO CITATION(S) 26843

26775 (SAND—77-2035) **User/programmer guide for UCMD 47: thin film resistor layout.** Wiegandt, K.E. (Sandia Labs., Albuquerque, N.Mex. (USA)). Dec 1977. Contract EY-76-C-04-0789. 35p. Dep. NTIS, PC A03/MF A01.

This document describes program UCMD 47--an Applicon AGS/870 User Command for parametrically producing thin-film resistor layouts in three generalized configurations.

26776 Bivariate interpolation approach for efficiently and accurately modelling antennas near a halfspace. Brittingham, J.N.; Miller, E.K.; Okada, J.T. (Univ. of California, Livermore). *Electron. Lett.;* **13**: No. 23, 690-691(10 Nov 1977).

A method based on 2-dimensional, bivariate interpolation is described for use in evaluating the Sommerfeld integrals which arise in an integral-equation solution of antennas which interact with a halfspace. This approach provides the rigour of the Sommerfeld formulation with a computer time comparable to the perfect-ground problem.

WASTE PROCESSING PLANTS AND EQUIPMENT

REFER ALSO TO CITATION(S) 26573

COMBUSTION SYSTEMS

REFER ALSO TO CITATION(S) 25620, 25710, 25711, 25713, 25716, 25717, 26143, 26157, 26589

26777 (BNL—50644) **Brookhaven National Laboratory Burner-Boiler/Furnace Efficiency Test Project. Hydronic equipment findings report reference manual.** Batey, J.; Hoppe, R.; Salzano, F.J.; Berlad, A.L. (Brookhaven National Lab., Upton, N.Y. (USA)). Jul 1977. Contract EY-76-C-02-0016. 13p. Dep. NTIS, PC A02/MF A01.

A brief description is provided of the methodology, test facilities and procedures used by the Brookhaven National Laboratory Burner-Boiler/Furnace Efficiency Test Program. The enthalpy flow measurement technique for determining efficiency is explained and the test facilities and experimental parameters are outlined. The enthalpy flow method is compared to stack gas sampling techniques. Test procedures and the test result format are explained.

26778 (CONF-770885—1) **Boiler burner design criteria for retrofit with low-Btu gases.** Shoffstall, D.R. (Institute of Gas Technology, Chicago, Ill. (USA)). 1977. 60p. of Gas Technology, Chicago.

From 2. symposium on stationary source combustion; New Orleans, LA, USA (29 Aug 1977).

This research program was initiated to characterize the problems associated with retrofitting existing utility boilers with low-Btu gases manufactured from commercially available coal conversion processes. All the experimental results were gathered from a pilot-scale furnace fired with a movable-vane boiler burner at a rate of 2,250,000 Btu/hr. Low-Btu gases tested ranged in heating value from 300 Btu/SCF to 100 Btu/SCF and were synthetically produced with a natural gas reformer-generating system. Data were collected to permit a comparison between natural gas and low-Btu gases in the areas of flame stability, flame length, flame emissivity, changes in boiler efficiency, and NO/sub x/ emissions. The NO emission data yielded an activation energy of 153 kcal/mol compared to kinetic

models which predict 135 kcal/mol. This good agreement suggests that peak temperatures approaching the adiabatic flame temperature are controlling the rate of NO emissions. Thus, the use of the adiabatic flame temperature provides a good empirical method for predicting NO emissions from low-Btu gas combustion.

26779 (FE—2473-15) **Industrial application of fluidized-bed combustion: Phase I. Quarterly report, July 1—September 30, 1977.** Norcross, W.R. (Combustion Engineering, Inc., Windsor, Conn. (USA)). 29 Nov 1977. Contract EX-76-C-01-2473. 15p. Dep. NTIS, PC A02/MF A01.

Additional cold flow modeling tests to study defluidization of sections of the bed as a method of turndown and load control were completed. Sub-Scale Unit design and construction has continued. Materials are on site and most of the major equipment has been installed. Platforms and support steel are erected. Instrumentation has been assembled into the control panels and coal handling piping is complete up to the supply bins. The SSU construction activity is 25% complete. Preliminary design of the demonstration plant included: preparation of plant layout drawings, completion of boiler preliminary pressure part drawings and specifications, start of initial work on development of a boiler startup procedure based on transfer of ignition energy from an operating bed to an adjacent fluidized section, developed preliminary design of an air plenum chamber with independent air flow measurement and control, prepared preliminary specifications for gas cleaning equipment, prepared preliminary selection of boiler water treatment equipment, initiated a study on fuel costs at the mine and delivered to the site, sub-contracted soil testing work, continued work on Process Block Diagrams, equipment motor list and Heat and Mass Balance for plant. Preliminary design of the demonstration plant is 65% complete. Final design of the demonstration plant was started. Specifications are being written for the ID fan, compression and dryer, air and gas duct system, safety valves, and mechanical dust collector. Initial work on the boiler final design included specifications of the boiler materials and selection of drum internals. Site and Plant Approval activity has been initiated.

26780 (FE/2343—1) **Project acquisition and evaluation process for Atmospheric Fluidized Bed Combustion demonstration plant.** (Booz, Allen and Hamilton, Inc., Bethesda, Md. (USA). Booz, Allen Applied Research Div.). 30 Sep 1977. Contract EX-76-C-01-2343. 279p. Dep. NTIS, PC A13/MF A01.

Fluidized bed technology provides a method of burning coal of all ranks (including high sulfur, high ash, agglomerating, and caking coal) and meeting environmental standards without pretreatment or scrubbing. FBC will have its greatest potential in utilizing pressurized reactors with combined cycle turbine systems but the FBC technology closest to commercial readiness is Atmospheric Fluidized Bed Combustion (AFBC) combined with traditional Rankine steam cycles. The current state of the AFBC development program is that numerous bench-scale and process development units are completed or underway; a 30 MWe pilot plant is in the start-up and shakedown stage; a Component Test and Integration Unit is in the early construction stage; and conceptual designs are being performed for demonstration plants. ERDA is planning to award a contract for a 125-250 MWe demonstration plant by early fiscal year 1978. For reasons given, the timing of the AFBC demonstration plant is critical for its commercial acceptance.

26781 **Experimental studies on fluidized-bed combustion (1st report).** Hori, K.; Matsumoto, S.; Tatebayashi, J.; Hayashi, K.; Takabatake, T.; Ito, H.; Okada, Y. *Kawasaki Giho;* No. 63, 195-201(Mar 1977). (In Japanese).

As fluidized-bed combustion has many advantageous characteristics, it can be utilized in much process engineering. Furthermore, it can be applied to all kinds of industrial fields, such as incinerators, boilers and chemical reactors, especially since fluidized-bed combustion achieves low NO/sub x/ and SO/sub x/ emission by means of low temperature combustion and in-situ desulfurization with solid additive. So, it is one of the most effective methods for controlling the emission of air pollutants. In the first stage of an R and D program of fluidized-bed combustion technology, a small transparent 500 mm two-dimensional cold model was obtained. Fluidization, bubble behavior and effect of immersed tube were investigated. The results of the cold model test were extended using a 200 mm square fluidized-bed furnace. Quantitative measurements of the burning characteristics and low emission performance were obtained.

26782 **Development and use of a TV system for viewing flames.** Godridge, A.M. (Central Electricity Generating Board, Hants, Eng.). pp 95-102 of Operation of instruments in adverse environments, 1976. Knight, J. (ed.). London; Institute of Physics (1977).

From Conference on the operation of instruments in adverse environments; London, UK (4 Oct 1976).

See CONF-7610120—.

The use of closed-circuit television for viewing oil, coal and natural gas flames in furnaces is described. The main requirement is to keep the lens system and camera cool and clean using only a small amount of air. This is done by placing the lenses in a metal cylinder behind a quartz window and an infrared absorbing filter. The cooling air is admitted at the rear (camera) end of the cylinder, flows over the lenses and infrared filter in turn (removing the heat absorbed by the latter), and then is exhausted around the quartz window as a high-speed annuluar jet which keeps the unit clear of dust. The arrangement is normally used with the front of the cylinder flush with the inner furnace wall so that the field of view is unrestricted, and the whole unit presents only a small frontal area (less than 0.015 m^2) to the hot, dirty and corrosive furnace gases. When equipment is left on an operational boiler to run for long periods without supervision, it is provided with an automatic means of retraction in the event of cooling-system failure. There are forty oil-fired installations within the Central Electricity Generating Board using the extension lens system, in one form or another. Maintenance is generally reported as very small. Some work has been done to automatically detect flame failure or poor combustion at individual burners in any array, using the closed-circuit television equipment already installed in power stations.

UNDERGROUND ENGINEERING

REFER ALSO TO CITATION(S) 25703, 26577, 26591

MARINE ENGINEERING

REFER ALSO TO CITATION(S) 25748, 25749, 25761, 25827, 25870, 26124

26783 (NTIS/PS—77/0716) **Offshore structures (a bibliography with abstracts). Report for 1964—July 1977.** Habercom, G.E. Jr. (National Technical Information Service, Springfield, Va. (USA)). Aug 1977. 194p. NTIS PC N01/MF N01.

Offshore structures are investigated relative to their feasibility, design, construction, marine environments, and environmental impact. Nuclear power plants, floating cities, and airports are among the facilities included in the feasibility studies. (This updated bibliograhy contains 189 abstracts, 39 of which are new entries to the previous edition.)

26784 **Some problems in installing, commissioning and maintaining instrument systems in an offshore environment.** Spence, E.W. (BP Trading Ltd., London). pp 1-6 of Operation of instruments in adverse environments, 1976. Knight, J. (ed.). London; Institute of Physics (1977).

From Conference on the operation of instruments in adverse environments; London, UK (4 Oct 1976).

See CONF-7610120—.

The problems of interfacing equipment packages for minimum offshore work and the difference in value between man-hours saved and commissioning days saved are considered. Some comments are offered on offshore maintenance and the choice of materials to minimize the work required. Some questions on design philosophy for offshore instrument systems are discussed.

26785 **Passivation and corrosion.** Robertson, G.W.E. (Decca Radar Ltd., Surrey, Eng.). pp 19-25 of Operation of instruments in adverse environments, 1976. Knight, J. (ed.). London; Institute of Physics (1977).

From Conference on the operation of instruments in adverse environments; London, UK (4 Oct 1976).

See CONF-7610120—.

Passivation of a metal surface takes place when the electrochemical behavior of the metal corresponds to that of a more noble metal. A form of passivation of particular interest is the growth of oxide layers; for example, under conditions of high humidity, very thin oxide layers can form on electrical contacts. However, data is available which can be used as a guide to the selection of a more noble material. A considerable amount of information is available regarding the use of metals under various environmental conditions where corrosion due to chemical or electrochemical action is probable. In particular, information is now available regarding seawater conditions and contamination by sulfur dioxide. The most common form of laboratory test employed for the evaluation of materials is the salt spray test. When possible, the results from this test should be compared with those obtained by long-term marine exposure. Furthermore, it must be remembered that a particular electrochemical mode of degradation is being employed and this may not correspond with that encountered in practice. For practical purposes corrosion cannot be eliminated, but only reduced to what is hoped will be a tolerable level. Combinations of coatings, many of which are suitable for instrument work, are given in the literature. For severe conditions, protection is afforded by a sprayed metal coating followed by a chemically resistant paint of the type employed in chemical plants.

Special attention should be paid to fastenings exposed to marine environments, as these have to remain in working condition (although inactive) for long periods of time; they should consequently behave in a more noble manner than the surrounding metal. Several examples showing the results of corrosion tests are given.

POLLUTION CONTROL EQUIPMENT

REFER ALSO TO CITATION(S) 26668, 26678

26786 (PB—270548) **Survey of the application of flue gas desulfurization technology in the industrial sector.** (Energy and Environmental Analysis, Inc., Arlington, Va. (USA)). 22 Dec 1976. Contract FEA-CO-05-60469. 100p. NTIS PC A05/MF A01.

This report constitutes a status report on the application of flue gas desulfurization (FGD) technology on coal-fired boilers in the industrial sector, excluding electric utilities. The study addresses four questions: (1) to what extent is FGD being applied on industrial boilers; (2) does FGD technology operate effectively on relatively small-scale industrial applications; (3) what are the costs of FGD on industrial facilities; and (4) what motivations tend to lead industry to use FGD. (Portions of this document are not fully legible.)

26787 **Catalytic oxidation of calcium sulfite during removal of SO_2 from flue gases by the limestone method.** Govorov, V.V.; Gladkii, A.V.; Torocheshnikov, N.S. *J. Appl. Chem. USSR (Engl. Transl.);* **50**: No. 5, 949-953(May 1977).

Translated from Zh. Pripl. Khim.; 50: No. 5, 990-994(May 1977).

Manganese sulfate was shown to be an effective catalyst for oxidation of calcium sulfite suspensions; the kinetics of catalytic oxidation was studied over a wide range of parameters. It was shown that the oxidation reaction is accelerated considerably by the use of $MnSO_4$. Equations were derived for calculating the rate of this process during removal of SO_2 from gases by the limestone method in equipment with intensive mixing of the reacting phases.

PARTICLE ACCELERATORS

DESIGN, DEVELOPMENT, AND OPERATION

REFER ALSO TO CITATION(S) 27312

26788 (COO—1717-9) **Ohio University tandem Van de Graaff accelerator. Final report.** Lane, R.O. (Ohio Univ., Athens (USA)). Nov 1977. Contract EY-76-C-02-1717. 26p. Dep. NTIS, PC A03/MF A01.

A summary is given of the work carried out at the John Edwards Tandem Accelerator Laboratory of Ohio University during the period 1970 to 1977 on studies of neutron-nucleus interactions and nuclear structure using neutrons as probes. This work utilizes the main and unique characteristic of the accelerator: high current, high voltage tandem. Certain applied areas were also studied, such as the production of short-lived isotopes for use in medical diagnoses, production of very high neutron intensity to observe possible sputtering effects, and proton induced x-ray emission with a microprobe beam.

26789 **Rotating target neutron generators.** Booth, R.; Davis, J.C.; Hanson, C.L.; Held, J.L.; Logan, C.M.; Osher, J.E.; Nickerson, R.A.; Pohl, B.A.; Schumacher, B.J. (California Univ., Livermore (USA). Lawrence Livermore Lab.). *Nucl. Instrum. Methods;* **145**: No. 1, 25-39(15 Aug 1977).

The rotating target neutron source at the Lawrence Livermore Laboratory (RTNS-I) is the most intense dc 14 MeV neutron source now in operation. The source consists of a 400 keV air-insulated accelerator which bombards a titanium tritide target rotating at 1100 rpm. A maximum source strength of 6×10^{12} n/s can be produced by bombarding the target with a 20 mA beam of deuterons. Useful target life is approximately 100 h. By extrapolation of the technology of the present source two new neutron sources (RTNS-II) have been designed to produce 4×10^{13} n/s. These sources and the research facility to house them are now under construction. The facility will be operated by LLL as a national center for fusion reactor materials research.

26790 **Pulsed spallation neutron sources for slow neutron scattering.** Carpenter, J.M. (Argonne National Lab., Ill. (USA)). *Nucl. Instrum. Methods;* **145**: No. 1, 91-113(15 Aug 1977).

The role of pulsed spallation neutron sources for slow neutron spectroscopy is sketched. Various methods of neutron production, and some aspects of the spallation neutron production process are outlined. Accelerators for pulsed spallation neutron sources are discussed. Materials and coolants for neutron-producing targets and moderators are surveyed. The performance of moderators and the effects of varying size, composition, and temperature are summarized. Expressions for estimating moderator performance are given. The effect of moderator-reflectors, which enhance the slow neutron beam current at low energies, are examined. The ZING-P prototype pulsed neutron source and the proposed Intense Pulsed Neutron Source are described. Pulsed spallation sources are a new generation of sources for slow neutron spectroscopy which offer an order of magnitude improvement over currently available thermal neutron flux and several orders of magnitude greater epithermal flux.

26791 **Intense neutron source based upon the deuterium-stripping reaction.** Grand, P.; Goland, A.N. (Brookhaven National Lab., Upton, N.Y. (USA)). *Nucl. Instrum. Methods;* **145**: No. 1, 49-76(15 Aug 1977).

The need for an intense neutron source to be used in the development of radiation-resistant materials for fusion reactors has stimulated proposals for new source designs. This paper describes one such based upon the deuteron-stripping reaction. Details of the reaction are given and it is shown that an intense forward-directed beam of neutrons is emitted when deuterons bombard a low-Z target such as Li or Be. The design of a 35 MeV high-current deuteron LINAC is discussed, and a molten Li target configuration capable of absorbing a high power density is described. The outlines of a intense neutron source facility based upon these principles are given in the final sections of this paper.

26792 **160 kV, 200 mA dc accelerator for high 14 MeV neutron yield.** Hourst, J.B.; Roche, M.; Morin, J. (CEA Centre d'Etudes de Valduc, 21 - Is-sur-Tille (France)). *Nucl. Instrum. Methods;* **145**: No. 1, 19-24(15 Aug 1977).

This paper describes an electrostatic, low energy, high current accelerator (160 kV, 200 mA), being in routine operating for two years. The (d, T) reaction gives yields of 5×10^{11} n/s cm^2 for a neutron emission of 6×10^{12} n/s in 4π. In such conditions the irradiated surface has a 5 cm diameter. The deuteron beam supplied from a duoplasmatron source is conducted on a rotating tritiated target. The target is movable on a rail-guided carriage mechanism which allows for automatic changing.

26793 **Pulsed power applications to intense neutron source development.** Ramirez, J.J.; Toepfer, A.J.; Clauser, M.J. (Sandia Labs., Albuquerque, N.Mex. (USA)). *Nucl. Instrum. Methods;* **145**: No. 1, 179-183(15 Aug 1977).

The use of conventional and near term pulsed power technology to generate intense fluxes of neutrons for use in fusion reactor materials studies is discussed. Two types of neutron production mechanism are considered. For the immediate future, the use of single pulse or high rep rate intense ion beam sources is proposed to provide high fluxes of neutrons from beam-target interactions. Farther along in time, the use of intense ion or electron beams to initiate inertially confined fusion reactions will lead to intense sources of thermonuclear neutrons.

26794 **Characteristics of an intense neutron source based on the d+Be reaction.** Saltmarsh, M.J.; Ludemann, C.A.; Fulmer, C.B.; Styles, R.C. (Oak Ridge National Lab., Tenn. (USA)). *Nucl. Instrum. Methods;* **145**: No. 1, 81-90(15 Aug 1977).

A neutron source designed for fusion-related radiation damage studies has been built on the d+Be reactions. Using a 40 MeV, 20 μA deuteron beam from the Oak Ridge Isochronous Cyclotron neutron fluxes of (1-2) $\times 10^{12}$ n/cm^2 s are obtained over an area approximately 50 mm^2. The design of the source is described, together with time-of-flight and activation foil measurements of the thick target neutron yields from the ^{9}Be(d, n) reaction for the angular range from 0° to 90°. A dosimetry procedure based on these measurements is presented. In addition time-of-flight measurements of the thick target neutron yields for the Li(d, n) reaction are reported and compared to the ^{9}Be(d, n) results.

BEAM DYNAMICS, FIELD CALCULATIONS, AND ION OPTICS

REFER ALSO TO CITATION(S) 27215

26795 (BNL—23655) **Neutralization of positive particle beams by electron trapping.** Mobley, R.M.; Irani, A.A.; LeMaire, J.L.; Maschke, A.W. (Brookhaven National Lab., Upton, N.Y. (USA)). 1977. Contract EY-76-C-02-0016. 4p. (CONF-770940—22). Dep. NTIS, PC A04/MF A01.

From Symposium on the production and neutralization of negative hydrogen ions and beams; Upton, NY, USA (26 Sep 1977).

Initial results are presented of a planned series of experimental tests of positive ion beam neutralization, involving transverse space charge studies of a 720 keV 60mA H^+ beam in a drift region of 4.6

meters. Two conclusions drawn from the data are: (1) the change in transmission observed is consistent with complete neutralization in the drift pipe for grounded or negative electrodes, and with complete de-neutralization in the case of greater than +240 V electrodes; and (2) background gas ionization cannot be the main source of electrons. (PMA)

AUXILIARIES AND COMPONENTS

26796 (SLAC-PUB—1805) **Similarities among the radiation fields at different types of high energy accelerators.** Nelson, W.R.; Jenkins, T.M. (Stanford Linear Accelerator Center, Calif. (USA)). Aug 1976. Contract EY-76-S-03-036. 4p. (CONF-751025—2). Dep. NTIS, PC A02/MF A01.

From Course on high energy radiation dosimetry and protection; Erice, Italy (1 Oct 1975).

Comparisons are drawn between electron and proton shielding problems. The health physicist, charged with shielding either type of accelerator, may have a thick or thin shield problem. For the electron accelerator, he may be able to remove the photon component with medium or high Z materials close to the source, leaving a thick shield problem to solve. On the other hand, the health physicist at a proton accelerator always shields for hadrons; i.e., the photon component is always small. At both types of accelerators, muons may be a problem in the forward direction. If the shields are thick, then similar spectra should be observed to the degree that shield compositions are the same. Thus it is possible for health physicists at various accelerators around the world to use similar shielding codes and methods, and to compare measurements regardless of type of accelerator.

26797 (SLAC-PUB—1948) **Fast pulse beam generation systems for electron accelerators.** Koontz, R.F. (Stanford Linear Accelerator Center, Calif. (USA)). Jun 1977. Contract EY-76-S-03-0326. 4p. (CONF-770709—21). Dep. NTIS, PC A02/MF A01.

From 10. international conference on high energy accelerators; Serpukhov, USSR (11 Jul 1977).

Physics experiments making use of time-of-flight for neutral particle momentum analysis need very short, or single bunch electron beam pulses. The SLAC storage ring, SPEAR, requires two, one nanosecond injection pulses per accelerator rf pulse, and the new PEP storage ring will use a single one nanosecond pulse per accelerator rf pulse for filling. In both storage ring cases, the beam pulse generation must be synchronized to the ring operating frequencies. Generation of these pulses is accomplished with a combination of a fast pulsed grided gun and a synchronized transverse beam chopper. A discussion is given of the injector system, electron gun design, pulser systems, beam choppers, synchronizers, and fast beam pickups.

26798 **Compact beryllium target for production of fast neutrons.** Logan, C.M.; Booth, R.; Nickerson, R.A. (California Univ., Livermore (USA). Lawrence Livermore Lab.). *Nucl. Instrum. Methods;* **145**: No. 1, 77-79(15 Aug 1977).

The authors have designed a compact beryllium target which produces a neutron flux of approximately 10^{13} n/cm^2 s (E>1 MeV) when bombarded with 20 μA of 30 MeV deuterons. With simple modification this target would be capable of withstanding 100 μA.

ION SOURCES

26799 (BNL—23652) **Present status of negative ion acceleration and transportation from SP sources.** Sluyters, T.; Lam, C. (Brookhaven National Lab., Upton, N.Y. (USA)). 1977. Contract EY-76-C-02-0016. 4p. (CONF-770940—18). Dep. NTIS, PC A02/MF A01.

From Symposium on the production and neutralization of negative hydrogen ions and beams; Upton, NY, USA (26 Sep 1977).

A 150 keV acceleration tube was constructed to test acceleration of negative ions emitted from a SP source in a close coupled structure. Beams in excess of one ampere were accelerated up to 120 keV in beam pulses of 3 milliseconds.

26800 (BNL—23653) **High energy neutral injectors based upon negative ion plasma sources.** Sluyters, T.; Prelec, K. (Brookhaven National Lab., Upton, N.Y. (USA)). 1977. Contract EY-76-C-02-0016. 4p. (CONF-770940—21). NTIS, MF A01.

From Symposium on the production and neutralization of negative hydrogen ions and beams; Upton, NY, USA (26 Sep 1977).

Portions of document are illegible.

High energy neutral injectors based upon SP (surface plasma) negative ion sources are proposed, extrapolating recent experimental results obtained with a 1 A negative ion source and a 1 A, 120 kV, 10 ms negative ion accelerator. The advantages of such a system are a high power efficiency of about 70% and its basic simplicity: source, close coupled accelerator and neutralizer.

26801 (BNL—23654) **Cathode cooling systems for the magnetron and Penning H^- sources: a progress report of work at Brookhaven National Laboratory.** McKenzie-Wilson, R.B. (Brookhaven National Lab., Upton, N.Y. (USA)). 1977. Contract EY-76-C-02-0016. 5p. (CONF-770940—23). Dep. NTIS, PC A02/MF A01.

From Symposium on the production and neutralization of negative hydrogen ions and beams; Upton, NY, USA (26 Sep 1977).

The magnetron/Penning H^- sources being developed at Brookhaven National Laboratory have produced ion currents up to 1 A with pulse lengths of 10 ms. The pulse length is limited by heating of the cathode surface. Cathode thermal conditions were investigated and lead to the conclusion that a cathode cooling system must be capable of handling 3 kW cm^{-2} of heated cathode surface. A review of cooling fluid requirements coupled with an examination of possible cooling fluids, leads to the conclusion that demineralized water is a suitable cooling fluid when used under pressurized nucleated boiling conditions. A correlation is used to show that heat-flux of 1.25 kW cm^{-2} could be removed using current technology and that this heat flux may be extended to 3 kW cm^{-2} by use of the Hyper-Vapotron effect. The temperature of the working surface of the cathode may be varied over a small temperature range by varying the system pressure during operation.

EXPERIMENTAL FACILITIES AND EQUIPMENT

REFER ALSO TO CITATION(S) 26830, 26842, 27055, 27314

26802 (ANL-HEP-CP—77-60) **Crossing geometry for Main Ring on Doubler collisions.** Diebold, R.; Collins, T. (Argonne National Lab., Ill. (USA)). May 1977. Contract W-31-109-ENG-38. 16p. Dep. NTIS, PC A02/MF A01.

A discussion is given of the two basic methods for bringing about Main Ring on Doubler collisions: the transposed and kissing geometries. There are many variations in each case depending on parameters such as the amount of "prebending" given each beam by tilting nearby bend magnets. The 50-m length of the straight section is a severe limitation in both methods. In general, the transposed geometry has more flexibility and is better suited for experiments. For example, essentially the full 50 meters can be left free for experiments; this case has no common magnets and could be used with anti p's in the Doubler and protons in the Main Ring, if for some reason the two beams could not be stored in the same ring. Or, the luminosity can be increased by "squeezing" the beams to a smaller, even zero, crossing angle with a remaining free space of approximately 8 meters. The transposed case also has the advantage that the interaction point remains fixed, while in the kissing geometry it moves up and down as dictated by the ratio of beam momenta.

26803 (LBL—7156) **Initial results with the Berkeley on-line mass separator-RAMA.** Cerny, J.; Moltz, D.M.; Evans, H.C.; Vieira, D.J.; Parry, R.F.; Wouters, J.M.; Gough, R.A.; Zisman, M.S. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Nov 1977. Contract W7405-ENG-48. 15p. (CONF-771078—2). Dep. NTIS, PC A02/MF A01.

From Workshop on ISOL systems; Upton, NY, USA (31 Oct 1977).

Initial performance is described for a reasonably fast and universal (having little or no chemical selectivity) on-line mass analysis system used to expand capabilities in studying nuclei far from stability. The system is termed RAMA, an acronym for Recoil Atom Mass Analyzer. Basically, this system utilizes the helium-jet method to transport activity to a Sidenius hollow-cathode ion source which is coupled to a mass spectrometer. Initial experiments and planned improvements are discussed. Transport efficiencies of between 10 and 60 percent have routinely been achieved, though the latter is much more typical when conditions are optimized.

STORAGE RINGS

REFER ALSO TO CITATION(S) 26740, 26741, 26797, 26831

26804 (BNL—23532) **Prosaic use of stochastic cooling at ISABELLE.** Humphrey, J.W.; Pedersen, F. (Brookhaven National Lab., Upton, N.Y. (USA)). 31 Aug 1977. Contract EY-76-C-02-0016. 4p. (CONF-770753—5). NTIS, MF A01.

From Isabelle workshop; Upton, NY, USA (18 Jul 1977).

Portions of document are illegible.

Stochastic cooling of high current proton beams of use for ISABELLE is considered. Cooling the transverse vertical size of the coasting proton beam might increase the maximum luminosity available. Even if the goal of increasing the luminosity of ISABELLE via this technique is not achievable, it may be possible to slow down the transverse blow up of the beams, and thus decrease the amount of scraping. This latter possibility may be of special interest for the high β configuration, where the circulating beam current is less (resulting in a shorter cooling time) and the experiments (nuclear-Coulomb

interference and small angle scattering) are more sensitive to the presence of beam "tails." A beam of 6 x 10^{14} protons is considered, and it is assumed that a gain of 1 is achievable, and that noise is negligible.

26805 (BNL—23533) **20 GeV e^+ x 400 GeV p: some synchrotron radiation considerations.** Humphrey, J.W.; Limon, P.J. (Brookhaven National Lab., Upton, N.Y. (USA); Fermi National Accelerator Lab., Batavia, Ill. (USA)). 1977. Contract EY-76-C-02-0016. 5p. (CONF-770753—18). NTIS, MF A01.

From Isabelle workshop; Upton, NY, USA (18 Jul 1977). Portions of document are illegible.

The possibility of a 20 GeV electron ring in the 400 x 400 GeV^2 ISABELLE tunnel is considered. The conclusions that can be drawn from these considerations are: (1) much work remains to be done on the implications of synchrotron radiation for insertion design; (2) in the absence of considerations concerning insertion areas with longitudinal polarization, placing the electron ring in the same vertical plane as the electron ring is mildly favored; (3) creating insertions for longitudinally polarized electrons is difficult, and elementary considerations indicate that the synchrotron radiation flux in the insertion region will increase by a factor of approximately 100 and the luminosity may decrease by a factor of approximately 10; and (4) the creation of insertions for longitudinally polarized electrons favors placing the electron ring in the same horizontal plane as the proton ring.

26806 (BNL—23534) **Exotic 4π detector for ISABELLE.** Humphrey, J.W.; Lanou, R.E.; Marx, M.; Rosenson, L. (Brookhaven National Lab., Upton, N.Y. (USA); Brown Univ., Providence, R.I. (USA); Massachusetts Inst. of Tech., Cambridge (USA)). 1977. Contract EY-76-C-02-0016. 4p. (CONF-770753—6). NTIS, MF A01.

From Isabelle workshop; Upton, NY, USA (18 Jul 1977). Portions of document are illegible.

An exotic detector system is proposed for use as a first round ISABELLE experiment. This detector covers the full solid angle around the intersection region and has good spatial resolution for both charged particles and photons. The detector can support and identify events with high multiplicity in an environment of 10^5 tracks/sec. The system can be triggered by scintillation counter arrays to select rare processes if desired. The detector system is shown and discussed.

26807 (BNL—23535) **Choice of harmonic number for the ISABELLE accelerating rf system.** Pedersen, F. (Brookhaven National Lab., Upton, N.Y. (USA)). 1977. Contract EY-76-C-02-0016. 10p. (CONF-770753—4). NTIS, MF A01.

From Isabelle workshop; Upton, NY, USA (18 Jul 1977). Portions of document are illegible.

Originally, h = 2 was chosen for the accelerating rf system to avoid growth of coupled bunch mode longitudinal instabilities. The ability to operate ISABELLE in a bunched mode and maintaining six interaction points plus the compatibility with the boxcar transfer scheme suggested for transfer from an eventual future accumulator ring has made it desirable to choose a different harmonic number, namely h = 3. It is shown in the following that the impedance threshold for these instabilities is higher than the impedance limit required during stacking to obtain design performance. The threshold is independent of the harmonic number, so the choice of h is free from an instability point of view, as long as we are below this threshold. For h = 3, the required peak voltage to produce the same acceptance and acceleration rate as the h = 2 system is 35 kV compared to 30 kV for the h = 2 system. The total stored energy in the h = 3 cavities will be less than in h = 2 cavities, so the cost is roughly unchanged. For the above mentioned reasons it is strongly recommended to choose h = 3.

26808 (BNL—23536) **Time required to replace an ISABELLE ring magnet.** Brown, D.P.; Kassner, D.A. (Brookhaven National Lab., Upton, N.Y. (USA)). 1977. Contract EY-76-C-02-0016. 2p. (CONF-770753—28). Dep. NTIS, PC A02/MF A01.

From Isabelle workshop; Upton, NY, USA (18 Jul 1977).

A brief discussion is given of the total elapsed time required to replace an ISABELLE ring magnet and restore the machine to operational status.

26809 (BNL—23538) **ISABELLE machine glossary.** Ferbel, T.; Herrera, J. (Rochester Univ., N.Y. (USA); Brookhaven National Lab., Upton, N.Y. (USA)). 23 Aug 1977. Contract EY-76-C-02-0016. 17p. (CONF-770753—17). NTIS, MF A01.

From Isabelle workshop; Upton, NY, USA (18 Jul 1977). Portions of document are illegible.

A brief glossary is presented, first giving those terms pertinent to betatron motion followed by those pertinent to synchrotron motion. More general terms are given toward the end.

26810 (BNL—23539) **Muon shield requirements for ISABELLE at 400 GeV/c.** Ludlam, T.; Thorndike, A.M. (Yale Univ., New Haven, Conn. (USA); Brookhaven National Lab., Upton, N.Y. (USA)). 26 Aug 1977. Contract EY-76-C-02-0016. 20p. (CONF-770753—8). Dep. NTIS, PC A02/MF A01.

From Isabelle workshop; Upton, NY, USA (18 Jul 1977). Portions of document are illegible.

A goodly portion of the ISABELLE ring lies above the existing contours of the land, and so a substantial earth berm is required to shield against penetrating muons which result from proton interactions within the ring. The size and shape of this shield is determined not only by the magnitude of expected proton losses from the circulating beams, but also by the geometry and magnetic structure of the machine, and the proximity of potential muon sources to the site boundary. The cost of constructing this berm is sufficiently great as to warrant detailed attention to the required shield thickness at each point around the ring. The report given updates previous discussions of the subject by incorporating the six-fold geometry and higher energy of the 400 GeV ISABELLE design, and taking advantage of a more refined study of the effects of magnetic deflection on the trajectories of muons produced within the lattice structure of the machine.

26811 (SLAC-PUB—1884) **Quantum lifetime in electron storage rings.** Chao, A.W. (Stanford Linear Accelerator Center, Calif. (USA)). Feb 1977. Contract EY-76-S-03-0376. 3p. (CONF-770313—135). Dep. NTIS, PC A02/MF A01.

From Particle accelerator conference; Chicago, IL, USA (16 Mar 1977).

One of the mechanisms which contribute to beam lifetime in electron storage rings is the quantum emission of energetic photons causing particles to be lost from the rf bucket. This quantum lifetime is among other things important in defining the required aperture in a storage ring. An approximate expression of quantum lifetime, predicted by a one-dimensional model which takes into account only the betatron motion, has been used in most storage ring designs. If the beam is aperture-limited at a position with nonzero dispersion, both the betatron and synchrotron motions have to be included and a two-dimensional model must be used. An exact expression of quantum lifetime for the one-dimensional case and an approximate expression for the two-dimensional case are given.

26812 (SLAC-PUB—1898) **RF system for the PEP storage ring.** Allen, M.A.; Karvonen, L.G.; Pellegrin, J.L.; Wilson, P.B. (Stanford Linear Accelerator Center, Calif. (USA)). Mar 1977. 3p. (CONF-770313—117). Dep. NTIS, PC A02/MF A01.

From Particle accelerator conference; Chicago, IL, USA (16 Mar 1977).

The main parameters of the rf system for the PEP storage ring are given. A total of 6 MW will be provided by twelve klystrons, each capable of delivering 500 kW of continuous rf power. Each klystron feeds two accelerating cavity sections, each 2.1 meters in length. The general layout is shown. The klystrons are housed in shelters above ground. The waveguides run through vertical penetrations to connect the klystrons to the accelerating cavities in the tunnel. The shelters are placed at three symmetrical regions around the ring. Low level circuits are described, and parasitic mode losses are discussed.

26813 (SLAC-PUB—1971) **Present and future colliding beam facilities at SLAC.** Wiedemann, H. (Stanford Linear Accelerator Center, Calif. (USA)). Jul 1977. Contract EY-76-S-03-0326. 12p. (CONF-770709—20). Dep. NTIS, PC A02/MF A01.

From 10. international conference on high energy accelerators; Serpukhov, USSR (11 Jul 1977).

In April 1972, the 3-GeV electron positron storage ring, SPEAR, was put into operation at the end of the linear accelerator at Stanford. By the recent discoveries in high energy physics the value of electron-positron storage rings for high energy physics has been clearly demonstrated. This development certainly encouraged the relatively early funding of the new electron-positron storage ring, PEP, at SLAC. In addition to its role as a particle physics research tool, SPEAR has been and remains a priceless model or prototype for larger storage rings like PEP. A few of the recent observations in SPEAR which have important implications to the design of PEP are described. Although the PEP design follows closely the SPEAR concept in many respects, it has its own distinctive and important features which are discussed in detail. Topics discussed include synchrotron-betatron resonances, beam losses, beam bunching, PEP design luminosity and energy, chromaticity correction in PEP, and the high energy cabability of PEP.

26814 (SLAC-PUB—2045) **PEP main ring magnet system.** Anderson, M.; Bell, R.A.; Cobb, J.; Early, R.; Jensen, D.; Nuttall, A. (Stanford Linear Accelerator Center, Calif. (USA)). Nov 1977. Contract EY-76-S-03-0326. 6p. (CONF-770842—19). Dep. NTIS, PC A02/MF A01.

From 6. international conference on magnet technology; Bratislava, Czechoslovakia (29 Aug 1977).

The PEP main ring magnet system consists of 192 bending magnets, 216 quadrupoles, 206 sextupoles and numerous other correction elements. The main ring bend magnets are laminated "C"

frame dipoles having a very uniform flat field meeting a new criterion of symmetry called the residual asymmetry factor (RAF less than or equal to 10^{-5}). The main ring quadrupoles consist of 216 laminated magnets of three differing lengths having a bore of 100 mm diam. The multipole content of these magnets as measured is less than or equal to 10^{-3}. The present status of both magnets is that production has begun and completion is scheduled for early 1979.

26815 (SLAC-PUB—2053) **Glow discharge processing vs bakeout for aluminum storage ring vacuum chambers.** Dean, N.R.; Hoyt, E.W.; Palrang, M.T.; Walker, B.G. (Stanford Linear Accelerator Center, Calif. (USA)). Nov 1977. Contract EY-76-S-03-0326. 11p. (CONF-771110—9). Dep. NTIS, PC A02/MF A01.

From 24. national vacuum symposium of the American Vacuum Society; Boston, MA, USA (8 Nov 1977).

Experiments were carried out on laboratory and prototype scale systems in order to establish the feasibility of argon discharge processing the PEP storage ring aluminum vacuum chambers. Electron-induced desorption rates showed significant reductions following bakeout and/or argon glow discharge treatment ($>10^{19}$ ions cm^{-1}). Data are presented and discussed in relation to advantages and problems associated with: water removal, argon trapping and subsequent release, electron energy dependence, discharge distribution, and surface plasma chemical effects.

INSTRUMENTATION

26816 **Operation of instruments in adverse environments, 1976.** Knight, J. (ed.). London; Institute of Physics (1977). 138p. (CONF-7610120—). Inst. of Physics, New York.

From Conference on the operation of instruments in adverse environments; London, UK (4 Oct 1976).

Included are thirteen papers, nine of which have been separately processed for the Energy Data Base.

RADIATION INSTRUMENTATION

GENERAL DETECTORS AND MONITORS

REFER ALSO TO CITATION(S) 27062

26817 (IAEA-SM—222/57) **Realistic calibration of whole body counters for measuring plutonium.** Parkinson, W.W. Jr.; Goans, R.E.; Good, W.M. (Oak Ridge National Lab., Tenn. (USA)). 1977. Contract W-7405-ENG-26. 22p. (CONF-771209—6). Dep. NTIS, PC A02/MF A01.

From IAEA symposium on national and international standardization of radiation dosimetry; Atlanta, GA, USA (5 Dec 1977).

The low energies and abundance of x-ray photons from ^{239}Pu make its detection in vivo one of the most difficult procedures in low-level radioactive counting. Standard practice is to reduce background by thick shielding, controlled atmospheres and electronic pulse shape discrimination. Monte Carlo photon transport calculations have been performed for the 14, 17 and 20 keV L x-ray photons from various distributions of plutonium in a simulated human chest and compared with measured counting rates from a uniform distribution and a point source in a Rando phantom. Agreement is reasonable for a ^{239}Pu calibration factor of 6.5 nCi per counts/min in the average human chest (25 mm tissue) for the paired 127 mm phoswich detectors of the Oak Ridge National Laboratory facility. The counting rate in the plutonium region for the average human subject is about 500 counts in 40 minutes, due largely to the ^{40}K content of natural potassium. The minimum detectable activity (MDA) of ^{239}Pu, at twice the standard deviation of this counting rate, corresponds to 6.6 nCi. Furthermore, unless recent uncontaminated counting data on the specific subject are available, it is necessary to allow for the normal ^{40}K radioactivity by deriving a ratio of the counts in the Pu spectral region (14-25 keV) to some spectral region characteristic of normal human radioactivity. The two regions utilized for this purpose at ORNL have been the 1.46 MeV ^{40}K photopeak and the 80-128 keV upper end of the phoswich spectrum. For an uncontaminated, male population at ORNL, the ratio of the Pu 14-25 keV band to the 1.46 MeV ^{40}K photopeak has been found to be 0.022 and that of the Pu to the 80-128 keV band was 0.15 with standard deviations for the population of 23% and 17%, respectively. When these standard deviations among the normal population are taken into account, the MDA for a human subject becomes 14 nCi of ^{239}Pu at the 2 sigma level.

26818 (LA—7009-MS) **Jupiter energetic particle experiment ESAD proton sensor design.** Gruhn, C.R.; Higbie, P.R. (Los Alamos Scientific Lab., N.Mex. (USA)). Dec 1977. Contract W-7405-ENG-36. 9p. Dep. NTIS, PC A02/MF A01.

A proton sensor design for the Jupiter Energetic Particle Experiment is described. The sensor design uses avalanche multiplication in order to lower the effective energy threshold. A complete signal-to-noise analysis is given for this design.

26819 (LA—7022-MS) **Calibration of a detector for pulsed neutron sources.** Veeser, L.R.; Hemmendinger, A.; Shunk, E.R. (Los Alamos Scientific Lab., N.Mex. (USA)). Feb 1978. Contract W-7405-ENG-36. 10p. Dep. NTIS, PC A02/MF A01.

A plastic scintillator detector for measuring the strength of a pulsed neutron source is described and the problems of calibration and discrimination against x-ray background for both pulsed and steady-state detectors are discussed.

26820 (SLAC-PUB—1768) **High energy photon response of moderated neutron detectors.** McCall, R.C.; Jenkins, T.M.; Tochilin, E. (Stanford Linear Accelerator Center, Calif. (USA); Varian Associates, Palo Alto, Calif. (USA)). Jun 1976. Contract EY-76-S-03-0326. 11p. (CONF-760652—7). Dep. NTIS, PC A02/MF A01.

From Health Physics Society meeting; San Francisco, CA, USA (27 Jun 1976).

In measuring the neutron dose, the experimenter has the problem of detecting neutrons in the presence of a high-energy photon field. It is the purpose of this paper to study the photon response of one type of neutron detector. The particular detector studied is a commercial moderator made of a cylinder of low-density polyethylene 6-1/4 inch diameter x 6-1/6 inches long. It is covered with 0.020 inches cadmium and an outer protective cover of 3/16 inch ABS plstic. The thermal neutron detector is an indium foil 2 inches diameter and weighing 2.7 grams. Neutrons are detected by the ^{115}In (n,γ) ^{116}In (T/sub $^1/_2$/ = 54 minutes) reaction. The foils were counted by a shielded pancake GM counter. The foils were counted about 1 hour after exposure and half-life measurements indicated no problems with other activation modes (e.g., (γ,n) reactions on either ^{113}In or ^{115}In). With these precautions, the only mode of photon detection is by (γ,n) reactions in the materials of the detector assembly. At higher energies, (γ,2n) and (γ,np) reactions may be significant. Results are presented and discussed. (WHK)

26821 (Y/DD—215) **Performance tests of the ORGDP radiation detection instruments.** Newton, C.E. (Oak Ridge Y-12 Plant, Tenn. (USA)). Aug 1976. Contract W-7405-ENG-26. 23p. Dep. NTIS, PC A02/MF A01.

Tests of the Oak Ridge Gaseous Diffusion Plant (ORGDP) radiation detection instruments were conducted in order to further document compliance with American National Standards Institute standard entitled Criticality Accident Alarm System. Neutron and gamma radiation, similar to that which would be experienced in a criticality accident, was generated by the Health Physics Research Reactor (HPRR)—a small, highly enriched uranium metal reactor. The HPRR was operated in two modes: (1) a burst mode in which yields ranging from 8 to 30 x 10^{15} fissions were obtained in a small fraction of a second, and (2) a steady-state mode in which smaller yields were obtained over one-minute intervals. The tests demonstrate that at a distance of 225 feet (68 meters), which is the present radius coverage for the ORGDP radiation detection instrument, the minimum criticality accident, as defined by the ANSI standard, could be readily detected. For line-of-sight locations, this radius coverage could be increased to 500 feet. The tests also indicate that the instrument response, in terms of radius coverage, is greater for neutron than for gamma radiation by a factor of about three.

26822 **Photon and electron response of silicon-diode neutron detectors.** McCall, R.C.; Jenkins, T.M.; Oliver, G.D. Jr. (Stanford Linear Accelerator Center, Stanford University, Stanford, California 94305). *Med. Phys.;* **5**: No. 1, 37-41(Jan 1978).

The photon response of silicon-diode neutron detectors is analyzed theoretically and measured in the 15—25-MeV region. The main mechanism for producing a response in the diode is shown to be the displacement of silicon atoms by scattering of electrons. If the photon source is an electron accelerator target, the response is mostly due to electrons originating in the target with a smaller contribution from electrons produced in the diode by photons generated at small angles to the beam.

26823 **Single-particle light-scattering measurements with a photodiode array.** Bartholdi, M.; Salzman, G.C.; Hiebert, R.D.; Seger, G. (Memorial Sloan-Kettering Cancer Center, New York, New York 10021). *Opt. Lett.;* **1**: No. 6, 223-225(Dec 1977).

A monolithic 128-element photodiode array is used to detect the light scattered between 7.5 and 21.5° with 0.1° resolution from single particles in a flow stream. The scan of the linear array is synchronized with the light-scattering event by a precursor signal. Monodispersed samples of polystyrene latex microspheres with diameters of 12.5, 15.7, and 19.8 μm were examined.

RADIATION DOSEMETERS

26824 (LA-UR—77-3001) **Photon and beta response of a new thermoluminescent dosimeter badge.** Cortez, J.R.; Storm, E.; Littlejohn, G.J. (Los Alamos Scientific Lab., N.Mex. (USA)). 1977. Contract W-7405-ENG-36. 17p. (CONF-780110—2). Dep. NTIS, PC A02/MF A01.

From 11. symposium on radiation instrumentation; San Diego, CA, USA (17 Jan 1978).

The Los Alamos Scientific Laboratory is in the process of converting from a film to a thermoluminescent dosimeter (TLD) badge. The new badge is made of Cycolac plastic and contains an aluminum card in which are mounted three TLD-700s and one TLD-600 LiF chips. One TLD-700 and the TLD-600 are within a cadmium filter and are used to determine the neutron exposure. The photon response of the TLD chips was measured over an energy range of 10 to 1000 keV. A TLD-700 chip, covered by a 90 mg/cm^2-thick copper filter embedded in a 250 mg/cm^2-thick Cycolac, was selected to measure penetrating radiation. A 60 mg/cm^2-thick Cycolac filter is used to measure nonpenetrating radiation. The photon energy and angular response of the TLDs under the penetrating and nonpenetrating filters is presented. The response of the badge to beta radiation, varying in maximum energy over the range of 0.77 to 2.3 MeV, is given. Finally, the accuracy of the new TLD badge in measuring photon radiation from plutonium is discussed.

26825 (PB—269776) **Semiconductor measurement technology: some aspects of dose measurement for accurate ion implantation.** Jamba, D.M. (Hughes Research Labs., Malibu, Calif. (USA)). Jul 1977. Contracts NBS-5-35891;ARPA Order-2397. 48p. (NBS-SP—400-39). NTIS PC A03/MF A01.

An investigation of various phases of semiconductor ion implantation dose measurement was carried out, covering in detail ion beam scanning, secondary particle suppression, and current measurement instruments. Problems are discussed and preferred techniques, electrode structures, and measurement circuitry are presented. Five current integrators were tested and are compared, especially in regard to pulsed current measurement.

26826 (PNL—2276) **Hanford critical radiation dosimeter.** Glenn, R.D.; Bramson, P.E. (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). Nov 1977. Contract EY-76-C-06-1830. 25p. Dep. NTIS, PC A02/MF A01.

The modified Hanford critical radiation dosimeter provides a rapid, accurate, and relatively inexpensive means of determining neutron and gamma radiation exposure dose from a radiation release of accident proportions. An accident is defined as a radiation release of such magnitude that personnel in the vicinity of the release may receive a total absorbed radiation dose in excess of the permissible limits. The neutron exposure estimation is arrived at rapidly by counting either the gold or TLD chips from the center of the paraffin moderator and performing the calculation. If the neutron spectrum has not been greatly degraded toward thermal energies, the dose value thus obtained will be accurate to within +-15%. Degradation depends on the amount and type of shielding material through which the neutrons pass before reaching the dosimeter. Shielding materials with a high hydrogen content, such as concrete, paraffin, and water, are usually used when neutron shielding is desired. Nonhydrogen-bearing shielding materials commonly used for beta and gamma radiation shielding, such as lead or iron, are relatively poor neutron shields.

26827 (UCRL—80183) **Gamma-ray dosimetry errors with TLDs.** Grahan, C.L.; Homann, S.G. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 13 Oct 1977. Contract W-7405-ENG-48. 15p. (CONF-771209—3). Dep. NTIS, PC A02/MF A01.

From IAEA symposium on national and international standardization of radiation dosimetry; Atlanta, GA, USA (5 Dec 1977).

Gamma-ray dosimetry errors can occur when thermoluminescence dosimeters (TLDs) are irradiated in thin-walled containers. An overresponse for LiF TLDs, irradiated by an isotropic source, of approximately 25% for ^{24}Na; 20% for ^{60}Co, and 2% for ^{137}Cs was observed. The overresponse for CaF_2 TLDs was found to be less than the overresponse of LiF TLDs. Underresponse errors can occur for TLDs in thin-walled containers irradiated under narrow-beam geometry conditions because electron equilibrium is not established, but this error is well known and is not discussed.

26828 **Least-squares technique for extracting neutron spectra from Bonner sphere data.** Zaidins, C.S.; Martin, J.B.; Edwards, F.M. (Nuclear Physics Laboratory, Department of Physics and Astrophysics, University of Colorado, Boulder, Colorado 80309). *Med. Phys.;* 5: No. 1, 42-47(Jan 1978).

The accurate assessment of neutron flux and dose-rate levels in a medical environment is a topic of much current interest. In this paper, a least-squares data-analysis technique has been used for extracting neutron spectra and related information from Bonner sphere data. This technique, incorporated in the fortran IV code nfls is worthy of consideration as an alternative to the count-rate ratios and iterative-unfolding techniques used in the past. The analysis provides calculated total neutron flux density, dose-equivalent rate, and average and median-neutron-energy information as well as a plot of integral neutron-flux-density spectra. The method allows the calculation of the statistical uncertainty of each of the above quantities, which has not always been possible with other analytical methods. Results of calibration and experimental data analysis are presented and compared to results of the iterative-unfolding technique.

NUCLEAR SPECTROSCOPIC INSTRUMENTATION

26829 **Optimization of the detector and associated electronics used for high-resolution liquid-scintillation alpha spectroscopy.** Thorngate, J.H.; Christian, D.J. (Oak Ridge National Lab., Tenn. (USA)). *Health Phys.;* 33: No. 5, 443-448(Nov 1977).

The performance of various reflector geometries, light coupling liquids, photomultiplier tubes, preamplifiers and linear amplifiers were compared and the configuration found that optimized the combination of pulse-height resolution and pulse-shape discrimination. The best combination used a hemispherical reflector, filled with distilled water, coupled to an 8575 photomultiplier tube, the output of which was conditioned by a special integrating preamplifier and a double-delay-line linear amplifier. Careful choice of the scintillator, sample preparation procedures, and electronic apparatus can produce liquid-scintillation alpha spectroscopy with a pulse-height resolution of 300 keV, or less, and, by using pulse-shape discrimination, background levels as low as 0.01 counts/min.

HIGH ENERGY PHYSICS INSTRUMENTATION

REFER ALSO TO CITATION(S) 26806, 27062

26830 (LBL—7215) **1K delay line digitizer.** Nunnally, C. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Oct 1977. Contract W-7405-ENG-48. 12p. (CONF-771023—33). Dep. NTIS, PC A02/MF A01.

From Nuclear science symposium; San Francisco, CA, USA (19 Oct 1977).

The initial External Muon Identifier (EMI) experiment at the Fermi National Accelerator Laboratory consisted of 30 Multiwire Proportional Chambers (MWPCs) with an equal number of discriminators and digitizers. Each chamber had seven outputs representing two signals per plane (X, Y and U) and a common signal called "prompt". These chambers were located around a 15-foot diameter bubble chamber that was placed along the neutrino beam line. At the time an average of five events were expected per 60 μs beam spill. Therefore, the first digitizers had seven independent channels with a maximum capacity of 16 words. However, the present EMI MWPC has 30 percent better resolution and nine output signals. Further, the event time has been lengthened at the accelerator resulting in additional events per beam spill. In order to take full advantage of these changes, a new digitizer, developed at the Lawrence Berkeley Laboratory (LBL), is described. The digitizer has nine input channels for accommodating all the signals (2 Xs, 2 Ys, 4 Us and a prompt) from one MWPC. Also, there is an internal channel that stores a flag for each wrap around of the memory data scaler. By using 1K ECL memories, the digitizer has a capacity of 1024 words and a 33 ns resolution.

26831 (SLAC-PUB—1844) **Drift chamber and pulse height readout systems using analog multiplexing.** Cisneros, E.L; Kang, H.K.; Hall, J.N.; Larsen, R.S. (Stanford Linear Accelerator Center, Calif. (USA)). Nov 1976. Contract EY-76-S-03-0376. 7p. (CONF-761006—51). Dep. NTIS, PC A02/MF A01.

From Nuclear science, scintillation and semiconductor counter symposium; New Orleans, LA, USA (20 Oct 1976).

Drift chamber and pulse-height readout systems are being developed for use in a new large scale detector at the SPEAR colliding beam facility. The systems are based upon 32 channels of sample-and-hold together with an analog multiplexer in a single-width CAMAC module. The modules within each crate are scanned by an autonomous controller containing a single ADC and memory plus arithmetic capability for offset, gain and linearity corrections. The drift chamber module has a facility for extracting hit wire information for use in trigger decision circuitry.

RADIOMETRIC INSTRUMENTS

REFER ALSO TO CITATION(S) 25908

26832 **Method for rapid particle size analysis by hydrosizing and nuclear sensing.** Daellenbach, C.B.; Mahan, W.M. US Patent 4,010,369. 1 Mar 1977. Filed date 29 Jan 1974. 10p.

The invention relates to the method and apparatus for determining the size and mass distribution of a randomly sized sample of particles. More specifically, the invention uses a series of liquid-

cyclones and a radiation attenuation detector to arrive at the discrete fractions of particle mass and size separated.

RADIATION EFFECTS ON INSTRUMENT COMPONENTS, INSTRUMENTS, OR ELECTRONIC SYSTEMS

26833 (AD-A—043519) **Description of the code SCALID for calculating the one dimensional SGEMP boundary layer. Topical report.** Carron, N.J. (Mission Research Corp., Santa Barbara, Calif. (USA)). May 1976. Contract DNA001-76-C-0086. 47p. (MRC-R—267).

This report is a description of, and a user's manual for, the FORTRAN code SCALID, which computes the time-dependent electron emission SGEMP boundary layer in one Cartesian dimension. It assumes no skin currents flow on the surface. The code solves the nonlinear Newton's laws for particle motion in the electric field produced by all electrons in the boundary layer.

26834 (AD-A—043776) **Integrated circuit electromagnetic susceptibility investigation. phase III. Summary report No. 2.** Roe, J.M.; Chott, J.R.; Chubb, C.R.; Kohlberg, C.N.; Larson, C.E. (McDonnell Douglas Astronautics Co., St. Louis, Mo. (USA)). 3 Jun 1977. Contract N60921-76-C-A030. 23p. NTIS PC A02/MF A01.

This report summarizes in a general manner the progress made in investigations into the susceptibility of integrated circuits (ICs) to RF power. This is an interim report covering the work performed in the second of three increments. This increment includes expansion of the modeling effort to incorporate the transistor models into a standard circuit analysis program SPICE (Simulation Program with Integrated Circuit Emphasis) so that RF effects on ICs can be modeled. The testing necessary to support the modeling effort is also included. A complete study of the damage mechanisms suffered by ICs under RF stress is also included in this report as second increment work. This damage study includes both modeling and an extensive testing program. The changes to the first draft of the IC susceptibility handbook and the rationale behind the changes are also included in this report.

26835 (AD-A—043777) **Integrated circuit electromagnetic susceptibility investigation. Phase III. IC susceptibility handbook-draft 2.** Roe, J.M. (McDonnell Douglas Astronautics Co., St. Louis, Mo. (USA)). 3 Jun 1977. Contract N60921-76-C-A030. 77p. (MDC-E—1669). NTIS PC A05/MF A01.

The objective of this handbook is to provide system designers with integrated circuit (IC) susceptibility information in terms of microwave signals. This is the second draft of the IC Handbook for comments from eventual users. The comments on the first draft have been studied and incorporated where possible. The data in this handbook include both interference and damage susceptibility. Both types of susceptibility are evaluated through modeling and testing. Both digital and linear ICs are covered in the handbook. This version includes all data available at the end of the second of three increments. The handbook explains the electromagnetic vulnerability (EMV) hardening approach for electronic systems. On the component level susceptibility reduction techniques such as lossy ferrite materials and screening for less susceptible devices are included. The handbook includes a description of the automated measurement system used to take and analyze the IC susceptibility data. This handbook will provide designers with actual test data when available and modeling techniques to determine susceptibility information where no test data are available.

26836 (AD-A—046169) **Ionizing radiation effects on silicon-on-sapphire devices and silicon dioxide films. Final report May 76—Apr 77.** Srour, J.R.; Othmer, S.; Curtis, O.L. Jr.; Chiu, K.Y.; Chen, S.C.C. (Northrop Research and Technology Center, Hawthorne, Calif. (USA)). Aug 1977. Contract DAAG39-76-C-0090. 203p. (NRTC—77-28R). NTIS PC A10/MF A01.

This report describes results of several related studies of ionizing radiation effects on silicon-on-sapphire devices and on silicon dioxide films. In the SOS investigation, emphasis was placed on the study of radiation-induced back-channel leakage current and on a comparison of devices with wet and dry gate oxides. Differing behavior for wet and dry devices is accounted for in terms of a larger density of hole traps in the sapphire for dry transistors as compared to wet units. SEM studies reveal that energy must be deposited in the sapphire before significant increases in leakage current will occur. In addition, such studies indicate that energy deposition deep in the sapphire bulk is relatively unimportant in producing leakage current. A process of radiation-induced reduction of leakage current was observed in which this current can be dramatically reduced to near its pre-irradiation value by simply reducing the applied drain bias to zero and continuing the irradiation. Models for radiations effects on SOS devices are presented. Measurements of the temporal, temperature, and electric-field dependences of radiation-induced charge transport have been performed for radiation-hardened SiO_2 films.

MISCELLANEOUS INSTRUMENTS

REFER ALSO TO CITATION(S) 25670, 25708, 26278, 26374, 26595, 26700

26837 (IS-T—792) **Laser two-proton excited fluorometric detection for high pressure liquid chromatography.** Sepaniak, M.J. (Ames Lab., Iowa (USA)). Dec 1977. Contract W-7405-ENG-82. 58p. Dep. NTIS, PC A04/MF A01.

Thesis.

A filter fluorometric liquid chromatography detector is constructed using a 1 mm I.D. x 3 mm O.D. quartz capillary tube as the flow cell and a laser as the excitation source. Fluorescence signals are monitored with a photomultiplier tube and photon counting system. The detector is described and characterized for the laser two-photon excited fluorometric (LTPEF) detection of the oxadiazoles PPD, PBD, and BBD, which are separated on a reverse phase ^{18}C column. Excitation is provided by the absorption of two photons of radiation at 5145 A from an argon ion laser. The detection limits, linearity of response, precision, and selectivity are reported and are found to compare favorably with other uv detection methods.

26838 (MHSMP—77-50) **Marco image converter camera. Period covered: July—September 1977.** Kramer, P.E. (Mason and Hanger-Silas Mason Co., Inc., Amarillo, Tex. (USA)). 1977. Contract EY-76-C-04-0487. 4p. Dep. NTIS, PC A02/MF A01.

The cause of the poor optical performance of the high-speed Marco Image Converter Camera was determined and successful corrective measures were taken. Future efforts involve the evaluation of the exposure and delay circuits to determine if the camera possesses useful capabilities.

26839 (RFP—2558) **Application of a GC/MS data system at Rocky Flats.** Turbett, J.R.; Grossaint, K.J.; Hunter, D.I. (Atomics International Div., Golden, Colo. (USA). Rocky Flats Plant). [nd]. Contract EY-76-C-04-3533. 36p. NTIS, MF A01.

Portions of document are illegible.

A data acquisition system is described which is used in the chemical analysis of complex-organic compounds. Using gas chromatography or mass spectroscopy, the system will store, produce, and replot data. Nanogram amounts can be detected. (FS)

26840 (RFP—2627) **Displacement technique for calibration for special nuclear material tankage volumes.** Shuler, L.E.; Doher, L.W.; Morrow, L.H. (Atomics International Div., Golden, Colo. (USA). Rocky Flats Plant). 1976. Contract EY-76-C-04-3533. 8p. Dep. NTIS, PC A02/MF A01.

A liquid volume calibration instrument using a nonconventional technique was needed for the sophisticated plutonium processing facility nearing completion at the Rocky Flats Plant of Rockwell International. It features displacement pistons standardized by dimensional inspection and uses automatic microprocessor control to provide validity checks and a complete data record. The instrument calibrates remote Special Nuclear Material (SNM) tankage of special design under program control but retains alternate operation modes and the ability to operate in general environments. Calibration data produced on punched paper tape is directly entered into an associated data base which provides analytical treatment in accordance with ANSI N15.19-1975, "Volume Calibration Techniques for Nuclear Material Control." Design considerations, operation, and the results of experiments are discussed. Some error sources are evaluated and composite advantages in the calibration of process tankage are given with emphasis on tank volume reliability for SNM measurements.

26841 (SAND—77-0841) **Degradation of EMP hardening devices.** Maxam, G.L.; Solberg, J.E. (Sandia Labs., Albuquerque, N.Mex. (USA)). Nov 1977. Contract EY-76-C-04-0789. 49p. Dep. NTIS, PC A03/MF A01.

In field applications, systems containing hardening devices will be subjected to a wide range of environments which may cause the effectiveness of the devices to degrade with time. Studies of the degradation of three hardening techniques, filtering, cable shields, and conductive gaskets are reported. The shielding effectiveness of double shielded cables was measured both before and after the cables were subjected to a series of bending, twisting, and environmental tests. The shielding effectiveness was found to degrade from the expected 60 dB to about 30 dB at some frequencies. Measurements on filter packs in systems subjected to field environments showed that the filters which had been expected to provide 50 dB of attenuation actually provided much less. Conductive gaskets are known to take a set when compressed for a long period of time. Measurements of the electromagnetic integrity of a sample gasket material under varying pressures were made.

26842 (SLAC-PUB—1840) **CC80-A microcomputer crate controller for CAMAC.** Walz, H.V. (Stanford Linear Accelerator Center, Calif. (USA)). Nov 1976. Contract EY-76-S-03-0376. 5p. (CONF-761006—50). Dep. NTIS, PC A02/MF A01.

From Nuclear science, scintillation and semiconductor counter symposium; New Orleans, LA, USA (20 Oct 1976).

A microcomputer crate controller has been developed for use in CAMAC based instrumentation, control, and data processing systems at the Stanford Linear Accelerator Center. This unit may be used in multicrate branch highway systems to provide local processing capability within each crate, or in a single crate to form a standalone CAMAC system.

26843 (Y/DA—7468) **Phase-insensitive detectors for ac resistance bridges with application to temperature control systems.** Duncan, M.G. (Oak Ridge Y-12 Plant, Tenn. (USA)). 28 Sep 1977. Contract W-7405-ENG-26. 11p. (CONF-780404—1). Dep. NTIS, PC A02/MF A01.

From IEEE region 3 conference and exhibit; Atlanta, GA, USA (10 Apr 1978).

A method of detecting AC resistance bridge error signals with low sensitivity to stray reactances is presented. The detector, which compares magnitudes of two bridge signals, can be used in a fast resistance temperature control to maintain constant resistance to better than 2 ppM at resistances down to 5 milliohms.

WELL LOGGING INSTRUMENTATION

REFER ALSO TO CITATION(S) 25829, 25908

26844 (AD-A—046114) **Use of borehole geophysical methods in determining in situ bulk densities and water contents in unconsolidated materials. Final report.** Hunt, R.W. (Army Engineer Waterways Experiment Station, Vicksburg, Miss. (USA)). Sep 1977. 61p. (WES-MP-S—77-18). NTIS PC A04/MF A01.

In situ bulk densities and water contents of unconsolidated materials have determined from geophysical logs obtained from borings in three separate geologic environments: desert alluvium, river alluvium, and loess. The geophysical logs used in the property determinations were natural gamma, gamma-gamma, neutron, and caliper. The geophysical (field) bulk densities and water contents were derived at depth intervals corresponding to sampled intervals where similar property data from laboratory analyses were available for comparisons. The field bulk densities ranged from about 5 percent lower to 11 percent higher and had an overall average of 1 percent higher than the laboratory bulk densities. The field water contents ranged from about 12 percent lower to 18 percent higher with an overall average of about 6 percent higher than the laboratory water contents.

EXPLOSIONS AND EXPLOSIVES

CHEMICAL

26845 (BDX—613-1668(Rev.)) **Digital analysis of EBW burst wave forms. Final report.** Lembke, J.R. (Bendix Corp., Kansas City, Mo. (USA)). Jan 1978. Contract EY-76-C-04-0613. 18p. Dep. NTIS, PC A02/MF A01.

The goal of this project was to digitally record and analyze the electrical waveforms associated with exploding bridgewire (EBW) burst, as a means of improving the characterization of EBW quality. Two fast transient digitizers were used to record the voltage and current waveforms generated during exploding bridgewire burst. Both digitizers were interfaced to a computer for automatic analysis of waveform characteristics. Programs were developed to align the two data sets in the time domain, and to compute and plot power, action, resistance, and energy as functions of time. A technique for automatic time calibration and amplitude calibration of the vidicon digitizer was developed, and software was written to apply calibration constants to the recorded data. A capability was added for creation of a data library for storage of burst data and calibration constants. Measurement accuracy was improved by design of a printed-circuit differential voltage divider, with integral voltage and current probes, to hold the part under test. With this device, error caused by the inductive component of measured burst voltage is negligible. Future applications of this capability will require provision of a suitable firing unit for each EBW type to be evaluated.

26846 (UCRL—52353) **Properties of benzotrifuroxan.** McGuire, R.R. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 27 Oct 1977. Contract W-7405-ENG-48. 28p. Dep. NTIS, PC A03/MF A01.

Benzotrifuroxan (BTF) is CO-balanced, hydrogen-free explosive that is sensitive to exploding bridgewire initiation. It has performance parameters equivalent to those of HMX-based explosives, but with a different isentrope. BTF is a chemically reactive material that forms compounds with electron-donating substrates. The procedures normally used to prepare BTF result in low levels of trinitrotriazidbenzene (TNTAB) that degrade its already limited thermal stability. However, BTF can be purified by recrystallization and can then be safely handled.

26847 **Thermal ignition time for homogeneous explosives involving two parallel .** Nunziato, J.W.; Kennedy, J.E.; Amos, D.E. (Sandia Labs., Albuquerque, NM). *Combust. Flame;* **29**: 265-268(1977).

An expression is derived for the thermal ignition time of a homogeneous explosive which is exothermically decomposing by two parallel Arrhenius reactions. The result involves the thermal ignition time of each reaction alone, and is expressed in terms of the hypergeometric function. Application of this analysis to the case of nitromethane ignition is illustrated.

26848 **Shock-wave evolution in chemically reacting solid.** Kennedy, J.E.; Nunziato, J.W. (Sandia Labs., Albuquerque, NM). *J. Mech. Phys. Solids;* **24**: 107-124(1976).

The evolutionary behavior of shock waves in the chemically-reacting solid (explosive) PBX-9404 has been observed using laser interferometry. These experimental results, along with the shock-amplitude relation for reacting, elastic materials, permit the determination of the energy release rate at the shock front as a function of compression. The results show that shock-wave evolution in PBX-9404 is dominated at low amplitudes by mechanical dissipation effects and at high amplitudes by the exothermic decomposition reaction at the front.

NUCLEAR

26849 (AD-A—042547) **Laboratory investigation of stemming and containment in underground nuclear tests. Final report.** Florence, A.L. (Stanford Research Inst., Menlo Park, Calif. (USA)). Oct 1976. Contract DNA001-75-C-0083. 88p. NTIS PC A05/MF A01.

As part of the DNA stemming and containment program for underground nuclear testing, laboratory investigatons were carried out in three areas: generation of experimental results suitable for correlation with predictions of computer codes used in DNA grout flow calculations, development of a containment experiment for studying residual stress fields around exploded cavities, and a theoretical analysis for studying the residual stress fields. Grout flow results were generated and supplied in a form suitable for code correlation. The containment experiment was brought to an advanced stage of development. The theoretical analysis, based on many simplifiying assumptions, was completed up to the second cavity expansion stage, resulting in a reasonable description of the stress field formation.

26850 (AD-A—043387) **Theoretical body and surface wave magnitudes for twelve numerically simulated cratering explosions. Topical report.** Bache, T.C.; Masso, J.F.; Mason, B.F. (Systems, Science and Software, La Jolla, Calif. (USA)). Jan 1977. Contract F08606-76-C-0041. 148p. (SSS-R—77-3119). NTIS PC A07/MF A01.

The results of the Systems, Science and Software contribution to a study of cratering explosions are presented. A series of twelve numerical simulations of 150 kt cratering explosions in three materials at several depths were carried out by Applied Theory, Incorporated. The data from these calculations were processed to compute theoretical far-field body and surface wave seismograms and from these to determine M sub b and M sub s. The M sub b and M sub s data are to be analyzed by Pacific Sierra Research. The theoretical seismogram calculations are done in a two-step process. First, an equivalent elastic source representation of the cratering event is obtained. The wave field is then propagated through realistic layered earth models to teleseismic distances. For this application the procedure is found to be more accurate for the shorter period body waves than for the surface waves. The M sub b and M sub s values are presented for the twelve 150 kt sources and for these sources scaled to 37.5 and 600 kt. Also given are the values for contained explosions of the same yield in the same emplacement material. The contribution of the ejecta fallback is studied and is found to be insignificant for teleseismic magnitude values.

26851 (AD-A—043398) **Laboratory investigation of rock cavity reinforcement. Final report, 17 September 1974—16 March 1976.** Kennedy, T.C.; Lindberg, H.E. (Stanford Research Inst., Menlo Park, Calif. (USA)). Apr 1976. Contract DNA001-75-C-0101. 222p. NTIS PC A10/MF A01.

The response of monocoque direct-contact and backpacked liners as hardened buried structures was studied through experiments on scale models (5/8-inch diameter tunnel), guided by analyses of structure and rock response assuming a Mohr-Coulomb rock

strength characterization. Two loading machines were modified to extend their capabilities and improve their performance. The modifications to the machines produced improvements in tunnel access, in sealing between vertical and lateral pressure chambers, in dynamic pressure pulses, and in general test procedures.

26852 (AD-A—043499) **Roscoe manual. Volume 14B. Midlatitude density profiles of selected atmospheric species. Final report, 2 March 1974—28 February 1975.** Myers, B.F. (General Research Corp., Santa Barbara, Calif. (USA)). 13 Jun 1975. Contract DNA001-74-C-0182. 137p. NTIS PC A07/MF A01.

Atmospheric density profiles are presented for the following species: atomic oxygen, molecular oxygen in the 1 delta g state, ozone, nitric oxide, atomic nitrogen, nitrogen dioxide, carbon dioxide, and water vapor. The profiles are intended to represent mean densities at midlatitudes for noon and midnight conditions. A review and limited discussion of recent observations and calculations are given.

26853 (AD-A—043524) **Laboratory investigation of infrared fluorescence of CO_2, HAES report number 60. Final report 1 AGusut 1975—31 December 1976.** James, T.C. (Lockheed Missiles and Space Co., Palo Alto, Calif. (USA). Lockheed Palo Alto Research Lab.). Dec 1976. Contract DNA001-76-C-0017. 43p.

This report summarizes experiments in which 4.3 micrometers emission is produced when CO2 is irradiated with 2.7 micrometers radiation. Measurements of the attenuation of this signal by various CO2 filled absorption cells are discussed. Absolute intensity measurements are also discussed. The evidence seems to suggest a large component of the 4.3 micrometers radiation is due to the bands 021-020 and 101-100. Complete characterization of the composition of the 4.3 micrometers emission will require detailed radiative transport calculations.

26854 (AD-A—043684) **Nuclear weapon effects uncertainties in tactical warfare. Final report, 2 June—3 Nobember 1975.** Millican, R.W.; Daugherty, W.L. (Stanford Research Inst., Menlo Park, Calif. (USA)). Oct 1975. Contract DNA001-75-C-0286. 88p. NTIS PC A05/MF A01.

The study identifies important uncertainties in regard to tactical nuclear warfare, devises methods for collecting battlefield data on these uncertainties, and proposes plans and procedures for collecting, evaluating, and disseminating the data to important users.

CIVIL USES

26855 (AD-A—042546) **Dynamic crater ejecta model. Final report, 1 October 1975—30 September 1976.** Seebaugh, W.R. (Science Applications, Inc., McLean, Va. (USA)). 30 Oct 1976. Contract DNA001-76-C-0023. 42p. (SAI—76-654-WA). NTIS PC A03/MF A01.

A dynamic model for the high explosive and nuclear crater ejecta environments is presented, together with selected results for a 1 MT surface burst on hard rock. The model provides both the ground deposition and airborne ejecta cloud environments. The effects of explosive type, yield and geology are taken into account in the model. The deposition results are obtained in the form of the cumulative mass and number of fragments impacting the ground plane per unit area, the ejecta depth, the fragment size class (minimum an maximum fragment diameters) and the minimum and maximum values for the impact time, velocity, angle, momentum and kinetic energy as functions of range from the burst point. The ejecta cloud environment is given in the form of mass and number densities as functions of spatial position and time.

26856 (UCRL—52362) **Bibliography of published material related to the Soviet PNE Program.** Ledbetter, G.P.; Nordyke, M.D. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 22 Nov 1977. Contract W-7405-ENG-48. 75p. Dep. NTIS, PC A04/MF A01.

Scientists in the Soviet Union have published many papers that provide details about the Soviet program for the peaceful use of nuclear explosions. Over the years much of this material has been gathered at the Lawrence Livermore Laboratory into what has become a sizeable collection. The bibliography of 334 references provides a useful record of the material available in that collection. The bibliography is divided into three main parts. Part I lists articles alphabetically. In Part II, the same articles are arranged by subject; many of them are included under more than one subject category. Part III is a list of important collections of papers. These collections provide many of the articles listed in Parts I and II.

26857 **Gas flow in a permeable earth formation containing a crack.** Pitts, J.H. (Univ. of California, Livermore); Brandt, H. *J. Appl. Mech.;* **44**: No. 4, 553-558(Dec 1977).

Gas flow in a permeable earth formation following an experimental underground nuclear explosion is analyzed to predict conditions that might lead to venting of radioactive gases to the atmosphere. A three-dimensional analysis considers flow of the explosion gas through the permeable earth formation as well as flow of the gas through a propagating crack. Effects of variations in permeability, k, from 10^{-6} to 1.0 $(\mu m)^2$ and ratio of the maximum resistive overburden pressure to the initial gas-driving pressure of explosions, P/sub r//sub max//P_1 from 0.1 to 0.9 are delineated. Initial dimensions of the crack range from 30 to 110 m in the vertical direction, 30 to 170 m in the horizontal direction and 10 to 50 mm in thickness. Propagation of a crack to the earth's surface following a typical experimental underground nuclear explosion buried at a depth of 500 m would require unusual conditions such as when k less than 10^{-4} $(\mu m)^2$ and P/sub r//sub max//P_1 less than 0.75.

WEAPONRY

REFER ALSO TO CITATION(S) 26886

26858 (AD-A—046146) **Event dice throw, mobility experiments. Final report.** Green, C.E. (Army Engineer Waterways Experiment Station, Vicksburg, Miss. (USA)). Aug 1977. 59p. (WES-MP-M—77-12). NTIS PC A04/MF A01.

Event Dice Throw, a 2.5-terajoule (600-ton) charge of ammonium nitrate-fuel oil (ANFO), was detonated on 6 October 1976 at the Giant Patriot Site on the White Sands Missile Range in New Mexico. The soil is predominatly loose silty sand with random lenses of hard silty clay. Field tests were conducted to determine the degree to which the crater and its associated ejecta field constituted a physical barrier to the movement of military vehicles. Four terrain units in the crater and ejecta area were delineated as significant to ground mobility and described in terms of soil strength, soil moisture content, surface configuration, ejecta depth, and areal extent. The test vehicles, i.e., and M60A1 tank, an M551 Sheridan tank, an M577A1 command post carrier, an M109 self-propelled howitzer, an M35A2C 2-1/2-ton cargo truck, and an M715 1-1/4-ton cargo truck, could operate with ease in all the terrain units except the crater wall. The crater wall was too steep for the vehicles to make a safe entry into the crater; therefore, a D7F bulldozer was used for 10 minutes to make an entrance lane into the crater. Comparison of measured values and values predicted by AMM-74X (Army Mobility Model) for four vehicle performance parameters revealed that the overall accuracy of the predictions for go-no go, draw-bar pull, motion resistance, and speed was acceptable in every case.

26859 (SAND—77-8291) **B77 GTU-8D full scale static load test of thinned wall titanium afterbody: SLL test No. 7411-3.** Vanderpoorten, J.E. (Sandia Labs., Livermore, Calif. (USA)). Dec 1977. Contract EY-76-C-04-0789. 94p. Dep. NTIS, PC A05/MF A01.

Pertinent data of the GTU-8D afterbody static load tests are presented. GTU-8D is a thinned wall version of GTU-8A (Test 7411). Testing methods and load levels are similar. The aft case was first coated with photo stress material to determine the stress flow patterns and then subjected to lifting parachute loads of 200,000 lbs. axial and 50,000 lbs. side loading. The tests were conducted on the SLL structural test facility in August, 1977.

EXPLOSION DETECTION

26860 (AD-A—042275) **Vela network evaluation and automatic processing research. Final report, 1 July 1975—30 October 1976.** Turnbull, L.S. Jr. (Texas Instruments, Inc., Dallas (USA)). 29 Oct 1976. Contract F08606-76-C-0011. 47p. (TI-ALEX—(01)-FR-76-01). NTIS PC A03/MF A01.

Work performed on Contract Number F08606-76-C-0011 has been reported in detail in a series of ten technical reports. This final report summarizes the material covered in each of the technical reports and discussed the conclusions obtained. The four tasks in the program included the following: Evaluate available data from the Iranian Long Period Array (ILPA) and the Seisimic Research Observatories (SRO), and evaluate the detection capability of the Korean Seismic Research Station (KSRS) using an optimum seismic detector; Evaluate the detection capability of a global seismic network of arrays, and determine the effectivenesss of an adpative beamforming algorithm as a short-period (SP) detector applied to off-line beam SP KSRS data; Determine the improvements in long-period signal estimation by cascading previously developed techniques; and Evaluate the discrimination capability of an expanded interactive graphics system for the PDP-15 computer.

26861 (AD-A—042571) **Multiple seismic events.** Taylor, R.W.; Willis, D.E. (Wisconsin Univ., Milwaukee (USA). Dept. of Geological Sciences). 15 Mar 1975. 125p. NTIS PC A06/MF A01.

It is shown is this study that the relationships of the delay times of secondary arrivals to the distance and azimuth of the recording stations provide a potential method of differentiating the source characteristics of an event. Cepstrum analysis is the method used to detect the delay times of secondary arrivals and was applied in the first zone study to selected Nevada Test Site events and one

natural earthquake. The theoretical basis of cepstrum analysis was extended to include three secondary arrivals, and formula was established for recovering the scaling factor of secondary arrivals with respect to the initial P arrival from an event. The results indicate that cepstrum analysis can be used to detect the delay time of secondary arrivals, but it is difficult to interpret the delay-distance and delay-azimuth relationships and thereby identify the secondary arrivals. The detection of multiple events appeared possible in some cases, but station coverage requirements are severe. Knowledge of p(P) within 500 km of a source has possibly been extended.

26862 (AD-A—042632) **Interim report on phase I expansion of the seismic communication and control processor system (CCP). Technical report, 30 June—31 December 1976.** Briscoe, H. (Bolt, Beranek and Newman, Inc., Cambridge, Mass. (USA). Computer Systems Div.). Apr 1977. Contract F08606-75-C-0022. 23p. (BBN—3531). NTIS PC A02/MF A01.

The seismic network and the CCP are being modified to accept on-line data from LASA and four or five North American Network stations over leased lines and from NORSAR over the ARPANET. This represents a potential increase in throughput of about 50%. The CCP is being upgraded in two phases to meet the projected load increase. The effort described in this report is the first phase of the upgrading. It included increasing the private and shared memory in the CCP, designing and coding the input software for leased line North American Network stations, and a design study for buffered interface hardware for leased line data.

26863 (AD-A—043386) **Explosion yield verification, multiple explosion scenarios and three-dimensional seismic modeling research. Quarterly technical report, 1 May—31 July 1976.** Lambert, D.G.; Petersen, C.F.; Savino, J.M. (Systems, Science and Software, La Jolla, Calif. (USA)). Aug 1976. Contract F08606-75-C-0045. 55p. (SSS-R—76-2993). NTIS PC A04/MF A01.

A procedure for directly inverting teleseismic ground motion data in order to obtain estimates of explosion yields was developed. The particular inversion scheme employs a deterministic modeling capability which predicts the teleseismic ground motion from a nuclear explosion. This procedure supplements expected data exchange packages that provide information on the near explosion source environment. Experiments involving computer simulation decomposition of multiple explosion scenarios were recently initiated. Application of narrow band filtering to synthesized multiple event seismograms has yielded accurate determinations of the relative amplitudes and time separations between individual explosions in the multiple explosion event examined. Preparations are nearing completion for a series of three-dimensional seismic modeling experiments. The intent of these experiments is to measure differences in signals between single and multiple sources and between near surface and deeply-buried sources. Theoretical explosion calculations will be compared to the experimental results.

26864 (AD-A—043389) **Seismic studies for improved yield determination. Quarterly technical report, 1 January—31 March 1977.** Barker, T.G.; Baker, M.; Coleman, P.; Lambert, D.G. (Systems, Science and Software, La Jolla, Calif. (USA)). Apr 1977. Contract F08606-76-C-0041. 53p. (SSS-R—77-3191). NTIS PC A04/MF A01.

The report summarizes the results of the second three months of research on a contract whose main objective is to examine the parameters that effect the seismic signals from underground nuclear explosions. Results were presented on research in five areas: (1) data pertinent to regional bias in M sub b and M sub S in the United States and central Asia were summarized; (2) signals simulating those from multiple explosions were decomposed and scaled by narrow-band filtering methods; (3) numerical simulations of contained explosions were compared with previous laboratory simulations; (4) laboratory experiments of cratering explosions were completed using 0.25 gram charges embedded in concrete; and (5) the primary factors controlling amplitude-yield scaling at regional distances were investigated.

26865 (AD-A—043390) **Simulation and decomposition of multiple explosions. Topical report.** Lambert, D.G.; Bache, T.C.; Savino, J.M. (Systems, Science and Software, La Jolla, Calif. (USA)). Jun 1977. Contract F08606-76-C-0041. 76p. (SSS-R—77-3194). NTIS PC A05/MF A01.

The purpose of the study is to develop procedures for using seismic measurements to verify the number and yields of individual explosions making up a multiple event. Multiple explosion seismograms are simulated by straightforward summations of single explosion records. Several types of multiple explosions are simulated. These include closely spaced equal yield explosions (no consideration given to propagation path effects between explosions and receiver) and relatively more widely spaced explosions (propagation path effects included) of varying yields. The data employed are principally close-in seismic recordings of the Nevada Test Site explosions obtained from Sandia Laboratories in Albuquerque, New Mexico. Decomposition of the simulated multiple explosion records is accomplished using a series of narrow-band filters with center frequencies ranging from 3 to 100 Hz. In general, our results show that the narrow-band filter technique is able to achieve accurate time separation and amplitude scaling. The limitation on the technique is essentially the requirement for the presence of sufficient signal energy at frequencies greater than about 3.5 times the inverse of the lag time between arriving signals.

ENVIRONMENTAL SCIENCES, ATMOSPHERIC

REFER ALSO TO CITATION(S) 26990

26866 **Comparison of aerosol and momentum mixing in dust storms using fast-response instruments.** Porch, W.M.; Gillette, D.A. (Lawrence Livermore Laboratory, University of California, Livermore, California 94550). *J. Appl. Meteorol.;* **16**: No. 12, 1273-1281(Dec 1977).

Fast-response light scattering measurements at two heights during a Texas dust storm are combined with horizontal and vertical wind data to derive and compare aerosol flux estimates using three techniques. The major result of this study is that a relative equivalence exists between the fine-particle ($0.1\mu m < radius < 1\mu m$) exchange coefficient and the eddy viscosity of the wind. The data also shed some light on the complex dependence of wind speed threshold for suspension and aerosol flux in high winds for different surface conditions and soil types. These results show the value of the experimental technique to studies of toxic particulat suspension and deposition by wind.

26867 **Acoustic detection of momentum transfer during the abrupt transition from a laminar to a turbulent atmospheric boundary layer[1].** Schubert, J.F. (Savannah River Laboratory, E. I. du Pont de Nemours Co., Aiken, S. C. 29801). *J. Appl. Meteorol.;* **16**: No. 12, 1292-1297(Dec 1977).

Acoustic sounder measurements of a vertical profile of the abrupt transition from a laminar to a turbulent atmospheric boundary layer were compared with meteorological measurements made at 10 and 137 m on an instrumented tower. Sounder data show that conditions necessary for the onset of the momentum burst phenomenon exist sometime during a clear afternoon when heat flux changes sign and the planetary surface cools. Under these conditions, the lowest part of the atmospheric boundary layer becomes stable. Prior to this situation, the entire boundary layer is in turbulent motion from surface heating. The boundary layer is then an effective barrier for all fluxes, and as the maximum flux Richardson number is reached at some height close to but above the surface, turbulence is dampened and a laminar layer forms. The profile of this layer is recorded by the sounder. Surface temperature drops, a strong wind shear develops, and the Richardson number decreases below its critical value ($Ri/sub\ cr/ < 0.25$). Subsequently, the laminar layer is eroded by turbulence from above, and with a burst of momentum and heat, it eventually reaches the ground.

BASIC STUDIES

26868 (ORAU/IEA(M)—75-3) **Energy and the climate.** Rotty, R.M. (Oak Ridge Associated Universities, Inc., Tenn. (USA)). Sep 1976. Contract EY-76-C-05-0033. 33p. Dep. NTIS, PC A03/MF A01.

The total global energy picture is reviewed and the consequences of man's energy use are postulated. It is pointed out that anthropogenic factors, and especially energy releases, can affect the world's climate. The release of energy to the atmosphere for eventual radiation to space causes a global warming. Per capita energy uses must be evaluated in making any projections as to the future global energy consumption rates, but any reasonable projection shows energy-use rates that cause concern with regard to effects on the climate. Localized energy releases give local and regional changes that will be apparent before the global changes. Cities have different climates than the nearby rural areas. Heat-flux density is an important consideration in evaluating meteorological changes resulting from large localized heat sources. Enhancement of convective cloud activity (including showers and thunderstorms) is possible if the heat-flux density is high. Aerosols released to the atmosphere can cause a warming or cooling effect depending on the nature of the aerosol and the albedo of the surface below. Changes in cloud cover are important in changing the radiation budget of the planet. Extensive irrigation, artificial reservoirs, and large cooling towers all add humidity to the atmosphere, but any resulting increase in cloudiness will tend toward overall cooling which will tend toward a reduction in cloudiness. Increases in atmospheric CO_2 (e.g., from the combustion of fossil fuels) add to the absorption of long wave radiation and

the resulting greenhouse effect. The resulting planetary warming depends on the amount of CO_2 uptake by the biota and by the oceans.

CHEMICALS MONITORING AND TRANSPORT

REFER ALSO TO CITATION(S) 26419, 26920

26869 (AD-A—046052) **Study of aerosol assessment instrumentation. Final report Jun—Oct 76.** Ranade, M.B. (IIT Research Inst., Chicago, Ill. (USA)). Sep 1977. Contract DAAA15-76-C-0122. 89p. (IITRI-C—6370-1). NTIS PC A05/MF A01.

Under this program, an up-to-date survey of commerical instruments available for measurement of aerosols was conducted. Aerosol properties of interest were size, concentration, stability, and composition. Aerosol instruments were classified according to their measurement principles and capabilities. An analysis of cost effectiveness for a specific application was performed after identifying the information required and instrument capabilities. (Author)

26870 (AED-Conf—77-165-002) **Remote sensing using tunable lasers.** Rothe, K.W.; Walther, H. (Beschleunigerlaboratorium der Univ. und Technischen Univ. Muenchen, Garching (Germany, F.R.)). 1977. 15p. Dep. NTIS (US Sales Only), PC A02/MF A01.

Summarizing the present situation of pollution monitoring by means of LIDAR it can be said that it is proven that the differential absorption method is the most sensitive technique known at present. TEA lasers are suitable light sources for a general application in the infra-red spectral region. The sensitivity which can be expected with those lasers allows to probe the atmosphere in the vicinity of chemical factories or other pollution sources over distances of about 3 km. Further improvements are possible e.g. by the use of heterodyne detection or by the use of frequency up-conversion for signal detection. A considerable step forward can still be expected when continuously tunable lasers as e.g. parametric oscillators of sufficient output power are used for the measurements.

26871 (BNL—23579) **Comparative effects of coal and nuclear fuel on mortality.** Morris, S.C. (Brookhaven National Lab., Upton, N.Y. (USA)). Aug 1977. Contract EY-76-C-02-0016. 7p. (CONF-770874—3). Dep. NTIS, PC A02/MF A01.

From Proceedings of the statistical computing section-American Statistical Association; Chicago, IL, USA (15 Aug 1977).

A key part of risk assessment is estimation of population exposure. This might ideally be a compilation of the number and characteristics of people exposed to given kinds, levels, and combinations of risk. The compilation ideally would be sufficiently disaggregated to allow calculation of the joint frequency of various combinations of risk to which a single population might be exposed. The number of people exposed at each level of risk is important since the true health damage function (or dose-response function) is likely to be nonlinear. At this point, in our models, we are not considering synergisms. We attempt to define the population exposed, and the degree of exposure, but treat the population at each exposure level as a single class. We also use linear damage functions. While these probably do not adequately represent the true effects over a wide range of exposure, we believe they are adequate to predict the effect of small changes of exposure within the general range of previous observation. Moreover, in our air pollution models we are generally allocating part of the total effect of air pollution to a specific source. A linear model seems completely appropriate for this use. We measure mortality in excess or attributable deaths per power-plant year. Excess deaths is a convenient way to express changes in mortality rates.

26872 (BNL—23672) **Chemical composition of sulfate as a function of particle size in New York summer aerosol.** Tanner, R.L.; Garber, R.; Marlow, W.; Leaderer, B.; Leyko, M.A. (Brookhaven National Lab., Upton, N.Y. (USA)). 1977. Contract EY-76-C-02-0016. 31p. (CONF-7705108—1). Dep. NTIS, PC A03/MF A01.

From American Industrial Hygiene Association meeting aerosol technological symposium; New Orleans, LA, USA (22 May 1977).

Samples of airborne particles were collected in New York City during August, 1976 in connection with the New York Summer Aerosol Study (NYSAS) as follows: 12 hr, low volume samples were collected during daylight and darkness hours using a sampler based on the Sinclair diffusion battery; 24 hr, 6 min/hr high volume samples were collected on 4 in. circles of acid-treated quartz filters; and 24 hr high volume samples were collected on conventional 8 x 10 in. glass fiber filters and Andersen impactor apparatus. Extracts of low volume samples were analyzed and data for strong acid, ammonium and sulfate are herein reported. High correlation of ammonium and sulfate was observed in all fine particle size fractions. Fractions of sulfate in the nuclei and suboptical size ranges were remarkably close to values reported for rural ambient aerosols. Diurnal variations in sulfate and associated cations were insignificant. Speciated sulfate determinations from HiVol samples were compared with data from low volume samples and with sulfate data from HiVol samples obtained by two other laboratories using $BaSO_4$ gravimetric techniques. Agreement between these data was satisfactory considering the known artifact sulfate formation associated with collection on glass fiber filters.

26873 (BNWL—2219) **Environmental assessment methodology for the nuclear fuel cycle.** Brenchley, D.L.; Soldat, J.K.; McNeese, J.A.; Watson, E.C. (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). Jul 1977. Contract EY-76-C-06-1830. 153p. Dep. NTIS, PC A08/MF A01.

Separate abstracts were prepared for two sections of this report.

26874 (BNWL—2219, pp 31-48) **Assessment methodology for chemical effluents.** Jul 1977.

In Environmental assessment methodology for the nuclear fuel cycle.

The objective of this environmental assessment is to define the present and future needs for controlling chemical effluents from nuclear fuel cycle facilities. These needs are defined by the environmental requirements for human health and welfare. Environmental quality standards are used to assess environmental impact and to calculate the degree of control required for specific chemical effluents. The environmental assessment of chemical effluents would be quite straightforward if emission standards and/or control equipment specifications existed for each chemical effluent and source. In recent years federal laws on water and air pollution have developed some regulations of this nature. However, the regulations do not cover all of the chemical effluents emitted from nuclear fuel cycle facilities. Development of additional regulations is presently hampered by the lack of specific knowledge about the pathways, uptake, and responses to these chemicals. No recognized methodology presently exists which can be used to directly compute the environmental impact of chemicals. This absence of a standard methodology leaves many unresolved problems.

26875 (CONF-7710114—1) **Transport and transformation pathways of hazardous chemicals from solid waste disposal.** Van Hook, R.I. (Oak Ridge National Lab., Tenn. (USA)). 1977. Contract W-7405-ENG-26. 49p. Dep. NTIS, PC A03/MF A01.

From 5. life sciences symposium; Los Alamos, NM, USA (Oct 1977).

In order to evaluate the impact of hazardous chemicals in solid wastes on man and other organisms, it is necessary to have information about amounts of chemical present, extent of exposure, and chemical toxicity. This paper addresses the question of organism exposure by considering the major physical and biological transport pathways and the physicochemical and biochemical transformations that may occur in sediments, soils, and water. Disposal of solid wastes in both terrestrial and oceanic environments is considered. Atmospheric transport is considered for emissions from incineration of solid wastes and for wind resuspension of particulates from surface waste deposits. Solid wastes deposited in terrestrial environments are subject to leaching by surface and ground waters. Leachates may then be transported to other surface waters and drinking water aquifers through hydrologic transport. Leachates also interact with natural organic matter, clays, and microorganisms in soils and sediments. These interactions may render chemical constituents in leachates more or less mobile, possibly change chemical and physical forms and alter their biological activity. Oceanic waste disposal practices result in migration through diffusion and ocean currents. Surface area-to-volume ratios play a major role in the initial distributions of chemicals in the aquatic environment. Sediments serve as major sources and sinks of chemical contaminants. Food chain transport in both aquatic and terrestrial environments results in the movement of hazardous chemicals from lower to higher positions in the food web. Bioconcentration is observed in both terrestrial and aquatic food chains with certain elements and synthetic organics.

26876 (COO—2874-16) **New measure of association for spatial variables. Technical report No. 7.** Tjostheim, D. (Stanford Univ., Calif. (USA). Dept. of Statistics). 17 Mar 1977. Contract EY-76-S-02-2874. 55p. Dep. NTIS, PC A04/MF A01.

A new measure of association for spatial variables is proposed. The measure is based on the ranks of the observations and on the location coordinates of the measurement points. For two independent spatial variables it is shown that under optimal coordinate designs the variance of the measure is of order $1/kn$, where n is the number of data points and k is the dimension of the observation space. Conditions for asymptotic normality is stated, and asymptotic formulas for bias and variance are given also in the case of sampling from a population with a finite number of measurement points. Generalizations and departures from assumptions are discussed. The motivation for the new measure came from statistical modelling of air pollution data. In a statistical analysis of air pollution variables one of the major tasks consists in describing interrelationships between the various air pollutants themselves and in evaluating effects

on human health. An effective study of relations of this type requires a good measure of association between the variables. The measure of association proposed in this paper supplements the conventional correlation and rank correlation coefficients. In an appendix we present a program for computing some of these spatial association coefficients. The program is illustrated using air pollution data from the San Francisco Bay Area.

26877 (EPA—450/2-75-003) **State air pollution implementation plan. Progress report, July 1—December 31, 1974.** (Environmental Protection Agency, Research Triangle Park, N.C. (USA); Environmental Protection Agency, Washington, D.C. (USA)). Apr 1975. 102p. Protection Agency, Research Triangle Park, NC.

The progress made by States in implementing the Clean Air Act, specifically section 110, is assessed. This document discusses the status of the various components of State Implementation Plans, the progress that enforcement activities have made in bringing major emitters into compliance, and several of the pending issues that affect the SIP process. A description of the SIP process is also included to facilitate an understanding of increments of progress. The ultimate effectiveness of SIPs will be judged in terms of States meeting the national ambient air quality standards. An official determination will be made for a calendar year of data, in most cases beginning with the first quarter of calendar year 1976.

26878 (LBL—6372) **Priori predictive methods of assessing health effects of chemicals in the environment.** Kland, M.J. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Oct 1977. Contract W-7405-ENG-48. 23p. (CONF-771070—4). Dep. NTIS, PC A02/MF A01.

From Conference on water chlorination) environmental impact and health effects; Gatlinburg, TN, USA (31 Oct 1977).

Four techniques for assessing the multifactorial problems of toxicity and carcinogenicity of environmental pollutants are briefly described: structure/activity relationships (SAR), factor analysis (FA), pattern recognition (PR), and molecular connectivity (MC). While it is clear that none provides easy answers, it would appear that the more recent areas of PR and MC both merit more intensive investigation as predictive tools. In particular, the relative simplicity of the MC approach and the possibility of substantially reducing the empirical component are attractive incentives for pursuing further work in this area.

26879 (LBL—7211) **Automated elemental analysis using energy dispersive x-ray fluorescence analysis.** Jaklevic, J.M.; Gatti, R.C.; Goulding, F.S.; Loo, B.W.; Thompson, A. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Nov 1977. Contract W-7405-ENG-48. 8p. (CONF-771113—12). Dep. NTIS, PC A02/MF A01.

From 4. joint conference on sensing of environmental pollutants; New Orleans, LA, USA (6 Nov 1977).

The application of energy dispersive x-ray fluorescence analysis to the measurements of air particulate samples has been described in several recent publications. Among its many advantages, the possibility of automatic analysis for large scale monitoring programs has not been widely discussed. We describe the completion of a program in which a total of 34,000 air particulate samples have been collected and analyzed over the past two years. An automatic photon-excited energy dispersive spectrometer was used to obtain elemental concentrations for 27 elements on each sample. The sensitivity of the system is adequate to detect quantities of 10ngm/cm^2 or less in about six minutes per sample. The precision and accuracy of the results will be compared to statistical analyses of the data set. Summaries of the results are presented and the implications for air particulate monitoring discussed.

26880 (ORO—4394-4) **Wind effected redistribution of surface contamination. Final report, September 1972—August 1976.** Amato, A.J. (Norfolk State Coll., Va. (USA)). 1976. Contract EY-76-S-05-4394. 12p. Dep. NTIS, PC A02/MF A01.

Mathematical models for the diffusion-deposition-resuspension of particles of surface contamination are described that include an infinite crosswind line source diffusion model. Computer programs were developed for use in calculations of atmosphere-surface exchange of particulate and gaseous pollutants.

26881 (PB—270555) **Analysis of random errors in air-quality measurements. Final report.** Williamson, H.J.; Friedrich, O.M.; Stuart, J.D. (Radian Corp., Austin, Tex. (USA)). Jun 1977. Contract EPA-68-02-1383. 76p. (RAD—77-100-044-16-07). NTIS PC A05/MF A01.

An analysis has been performed of the random errors involved in measurements of ozone, SO2, NO, and NOx made with the Radian-built air-monitoring trailers. Differences observed between 'known' test gas concentrations and the corresponding machine responses were used to quantify the error properties. Data obtained through quality-assurance audits, performed both by EPA and Radian, and through daily autocalibrations of the instrumentation were analyzed.

26882 (PB—273788) **Source assessment: pressed and blown glass manufacturing plants. Final task report Sep 75—Jan 77.** Schorr, J.R.; Hooie, D.T.; Brockway, M.C.; Sticksel, P.R.; Niesz, D.E. (Battelle Columbus Labs., Ohio (USA)). Jan 1977. Contract EPA-68-02-1323. 143p. NTIS PC A07/MF A01.

This report summarizes the results of a study to gather and analyze background information and technical data related to air emissions from glass manufacturers producing pressed and blown glassware. This includes all glassware except flat glass, glass containers, and fiber glass. The report covers emissions from three areas within the plant: raw materials preparation and handling, glass melting, and forming and finishing operations. Emissions from the melting furnace account for over 80 percent of the total plant emissions. The major pollutants are NOx, SOx, and submicron particulates consisting predominately (80%) of mineral sulfates but can also include fluoride and borate compounds. NOx has the largest emission factor (4.5 g/kg) with annual emissions 57.5 x 10 to the 9th power g. In comparison with national emissions from stationary sources, NOx emission from glass melting furnaces contributes 0.17 percent of the total. The source severity is a measure of the potential environment effect of air emissions and is the ratio of the maximum average ground level concentration compared to the primary ambient air quality standard for criteria pollutants. For this study source severity factors determined were largest for NOx, SOx, lead (PbO), and other particulates. Other emissions had a low severity factor (<0.01).

26883 (PNL—2426) **Estimation of air concentrations due to the diffusion, deposition and resuspension of contaminants by the wind.** Horst, T.W. (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). Oct 1977. Contract EY-76-C-06-1830. 150p. Dep. NTIS, PC A07/MF A01.

A model is developed for the prediction of the air cncentration of a pollutant in the presence of a vertical flux of the material at the surface. This surface flux model integrates over the horizontal extent of the surface source/sink, assuming that the atmospheric diffusion from each differential increment of area is equal to that from a surface point source. Two specific processes are considered in specifying the areal source strength: a negative vertical flux due to dry deposition and a positive vertical flux due to the suspension of surface contamination by the wind. The deposition flux is assumed to be equal to the product of the near-surface air concentration and a deposition velocity v/sub d/ and the suspension flux to the product of the surface contamination and a resuspension rate Λ. It is shown that the surface flux model leads to a new method of accounting for deposition from a point source plume, called surface depletion, which allows empirical knowledge about the diffusion process to be applied directly to the diffusion of a depositing material.

26884 (UCID—17701) **PATRIC: a three dimensional particle-in-cell sequential puff code for modeling the transport and diffusion of atmospheric pollutants.** Lange, R. (California Univ., Livermore (USA). Lawrence Livermore Lab.). Jan 1978. Contract W-7405-ENG-48. 11p. Dep. NTIS, PC A02/MF A01.

PATRIC is a transport and diffusion code designed to calculate the three-dimensional distribution of atmospheric pollutants in a given space and time varying flow field. It is based on the particle-in-cell model in which the pollutant mass or activity is represented by the spacial distribution of a large number marker particles. The temporal evolution of this particle distribution results from the transport of each individual marker particle due to advection by the mean wind and diffusion by the Gaussian formula. The code is capable of computing instantaneous or time-integrated air concentrations and deposition for a variety of instantaneous or continuous sources, including inert and radioactive materials. PATRIC was developed as a simplified and speeded-up version of the Lawrence Livermore Laboratory three-dimensional transport and diffusion code for complex terrain ADPIC. PATRIC computer time is approximately one minute for every 24 hours modeled which makes the code suitable for annual air quality assessments.

26885 (ORNL-tr—4479) **Environmental effect of mercury, with particular attention to the Monte Amiata Zone.** Strappa, O. Translated by S.D. Blalock from *Ind. Miner.;* **27**: 121-132(1976). 29p. Dep. NTIS, PC A03/MF A01.

The following topics are discussed: history of the harmful effects of mercury vapor; mercury content of rocks, soils, and sediment in streams; mercury in natural water, thermal springs, and gaseous emissions; mercury in plants; mercury in the atmosphere; biological factors in mercury chemistry; lethal concentration of mercury in aquatic organisms; and mercury in the environment of the Amiata mercury-bearing areas. (HLW)

RADIOACTIVE MATERIALS MONITORING AND TRANSPORT

REFER ALSO TO CITATION(S) 25944, 26419, 26871, 26873, 26895, 26934, 26989, 26992

26886 (AD-A—046201) **Rainout.** Thompson, F.O. Jr. (Army Nuclear Agency, Fort Bliss, Tex. (USA)). Dec 1976. 11p. (Nuclear-notes—5). NTIS PC A02/MF A01.

Broadly speaking, rainout is the deposition on the earth's surface of radioactive particles (resulting from nuclear weapons bursts) through interactions of these particles with raindrops and rain clouds. For the atmospheric nuclear tests performed in the past, the possibility of rainout was recognized and then deliberately minimized by delaying the test when local precipitation existed in order to avoid any potential rainout hazard outside the test area. As a consequence, little useful rainout data were obtained from these tests. The end result was a phenomenon recognized qualtitatively to be a potential hazard, but of unknown intensity and extent. Recently, the scientific effort in the rainout area has been increased in order to determine the extent of potential militarily significant hazards and to develop a better understanding of the phenomenon.

26887 (DP-MS—77-41) **Jeremiah environmental computational system.** Buckner, M.R. (Du Pont de Nemours (E.I.) and Co., Aiken, S.C. (USA). Savannah River Lab.). 1977. Contract EY-76-C-09-0001. 13p. (CONF-771109—93). Dep. NTIS, PC A02/MF A01.

From ANS winter meeting; San Francisco, CA, USA (27 Nov 1977).

Portions of document are illegible.

A modular environmental transport and dose computational system (JEREMIAH) was developed to assess routine radioactive pollutant releases and emergency response capability for accidental pollutant releases. This system uses the modular programming interfaces and data management facilities provided by the JOSHUA operating system. The JEREMIAH system is primarily designed to handle pollutant releases from the Savannah River Plant (SRP); however, other nuclear facilities within the southeastern United States are included in the grid networks provided within JEREMIAH.

26888 (LA-UR—77-2968) **Integrated minicomputer alpha analysis system.** Vasilik, D.G.; Coy, D.E.; Seamons, M.; Henderson, R.W.; Romero, L.L.; Thomson, D.A. (Los Alamos Scientific Lab., N.Mex. (USA)). 1978. Contract W-7405-ENG-36. 33p. (CONF-780110—3). Dep. NTIS, PC A03/MF A01.

From 11. symposium on radiation instrumentation; San Diego, CA, USA (17 Jan 1978).

Approximately 1,000 stack and occupation air samples from plutonium and uranium facilities at LASL are analyzed daily. The concentrations of radio-nuclides in air are determined by measuring absolute alpha activities of particulates collected on air sample filter media. The Integrated Minicomputer Pulse system (IMPULSE) is an interface between many detectors of extremely simple design and a Digital Equipment Corporation (DEC) PDP-11/04 minicomputer. The detectors are photomultiplier tubes faced with zinc sulfide (ZnS). The average detector background is approximately 0.07 cpm. The IMPULSE system includes two mainframes, each of which can hold up to 64 detectors. The current hardware configuration includes 64 detectors in one mainframe and 40 detectors in the other. Each mainframe contains a minicomputer with 28K words of Random Access Memory. One minicomputer controls the detectors in both mainframes. A second computer was added for fail-safe redundancy and to support other laboratory computer requirements. The main minicomputer includes a dual floppy disk system and a dual DEC 'RK05' disk system for mass storage. The RK05 facilitates report generation and trend analysis. The IMPULSE hardware provides for passage of data from the detectors to the computer, and for passage of status and control information from the computer to the detector stations.

26889 (NP—22643) **Environmental report No. 22, January—June 1977.** Wilcox, D.P.; Smokowski, R.T. (Nuclear Fuel Services, Inc., West Valley, N.Y. (USA)). 31 Aug 1977. 29p. Fuel Services, Inc., West Valley, NY.

The Nuclear Fuel Services, Inc. spent fuel reprocessing plant is located at the western New York Nuclear Service Center, a 3,345-acre site located approximately 30 miles southeast of Buffalo in Cattaraugus County in Western New York. During the first half of 1977, over 800 separate analyses of air, water, milk, fish and silt were performed. These analyses indicated the concentrations of radioactivity in the environment are far less than the applicable limits of the U.S. Nuclear Regulatory Commission and the Federal Radiation Council.

REGULATIONS

26890 (PB—270896) **Cost/effectiveness analysis of the Illinois ozone episode regulation (R75-4). Final Report.** Cohen, A.S.; Macal, C.M.; Cavallo, J.D. (Argonne National Lab., Ill. (USA)). May 1977. 386p.

This report describes the procedures used to conduct, and the results of, a cost-effectiveness study of the Illinois episode control regulation as it pertains to ozone (oxidants), i.e., PCB R75-4. There are four episode stages that can be declared at specified ozone levels: (1) advisory, for ozone levels of 0.07 ppm; (2) yellow alert, 0.17 ppm; (3) red alert, 0.30 ppm; and (4) emergency, 0.50 ppm. No control actions are taken during advisories.

26891 **Das neue Bundes-Immissionsschutzrecht (BImSchV). (New Federal Act for protection against nuisances (BImSchV)).** Froeba, K.; Thomas, L. (comps.). Kissing, Germany, F.R.; WEKA (1977). 282p. (In German).

The text of the decree is included with introduction and comprehensive explanations. Furnaces (1st decree of BImSchV); Chemical purification installations (2nd decree of BImSchV); sulfur content of light fuel oil and diesel oil (3rd decree of BImSchV); installations subject to licensing (4th decree of BImSchV); persons responsible for protection against nuisances (5th decree of BImSchV); know-how and reliability of these persons (6th decree of BImSchV); ejection limitation for wood dust (7th decree of BImSchV); limitation of noise made by lawn mowing machines (8th decree of BImSchV); principles of the licensing procedure (9th decree of BImSchV). Text of the Federal Act for the Protection Against Nuisances.

26892 **Genehmigungsverfahren nach dem Bundes-Immissionsschutzgesetz. Text der Neunten Durchfuehrungsverordnung mit Erlaeuterungen und ergaenzenden Vorschriften. (Licensing procedures according to the Federal Act for Protection Against Nuisances. Text of the 9th implementation ordinance with explanations and supplementing regulations).** Schaefer, K. (Bundesministerium des Innern, Bonn (Germany, F.R.)). Wiesbaden, Germany, F.R.; Deutscher Fachschriften-Verl. (1977). 128p. (In German).

On March 1st, 1977 the 9th decree of Protection Against Nuisances came into force, which, as the first comprehensive and state-uniform regulation, contains the principles of the licensing procedure supplementary to legal provisions. The legal provision is based on numerous recent regulations of procedure from which in the meantime an essential stock of regulations relating to the licensing procedure has emerged. In general, two aims are to be achieved by this new regulation: The acceleration and simplification of the licensing procedure as well as an imperative guarantee of the rights of neighbouring areas and society in general by a constitutional state. The legal provision provides in part new legal instruments for this. Examples on which the legal provisions are based are presented in the introduction. Subsequent explanations of provisions of the decree are to assist the application of the new act. Relevant regulations of the Federal Act for Protection Against Nuisances, as well as further supplementary provisions, are given in the supplement.

ENVIRONMENTAL SCIENCES, TERRESTRIAL

REFER ALSO TO CITATION(S) 26990

BASIC STUDIES

REFER ALSO TO CITATION(S) 25943, 25945, 25946, 25947, 25950, 25951, 25952, 27004, 27005

26893 (ORAU—129) **Ecosystem paradigm for ecology.** Johnson, P.L. (ed.). (Oak Ridge Associated Universities, Inc., Tenn. (USA)). Apr 1977. Contract EY-76-C-05-0033. 18p. Dep. NTIS, PC A02/MF A01.

This parodigm represents the viewpoints of participants of a workshop on the nature of ecosystem ecology as a science. Although the statements presented did not find unanimous agreement among the participants, they do integrate the current scope and focus of ecosystem ecology. It was concluded that: the ecosystem is both a conceptual and operational organizational level displaying both characteristic structural and functional attributes such as biogeochemical cycling and energy flow; the ecosystem represents the net of all the interacting individual elements, living and non-living; and the effects of human activity are important parameters in most ecosystems.

26894 (SRO-NERP—1) **Snakes of the Savannah River Plant with information about snakebite prevention and treatment.** Gibbons, W. (Savannah River Ecology Lab., Aiken, S.C. (USA)). Sep 1977. Contract EY-76-C-09-0001. 26p. Dep. NTIS, PC A03/MF A01.

Snakes not only have an indirect ecological effect, but they may also have a most direct impact on man. The effect may be physiological as a result of poisonous snakebite, or it may be psychological as a consequence of the almost universal fear and misunderstanding that people have of snakes. The severity of both the physiological and psychological potential can be diminished with some knowledge of the ecology and behavior of the snakes found in one's own geographic region. The purpose of this booklet is to point out what we know and what we do not know (but should know) about the snakes of South Carolina with emphasis on those found on the Savannah River Plant (SRP). Hopefully sufficient information is given to alleviate unnecessary fears concerning the many species of nonpoisonous snakes. A second intent is to point out the necessary steps for avoidance of poisonous snakebite and to indicate the current medical recommendations for emergency treatment should it ever be needed.

26895 (TID—26712) **Environment of Amchitka Island, Alaska.** Merritt, M.L.; Fuller, R.G. (eds.). (Sandia Labs., Albuquerque, N.Mex. (USA); Battelle Columbus Labs., Ohio (USA)). Sep 1977. 696p. Dep. NTIS, PC A99/MF A01.

Separate abstracts were prepared for the 26 papers presented in the report. (HLW)

26896 (TID—26712, pp 35-51) **Hydrology.** Dudley, W.W. Jr.; Ballance, W.C.; Glanzman, V.M. (Geological Survey, Lakewood, CO). Sep 1977.

In Environment of Amchitka Island, Alaska.

Amchitka Island is composed of stratified volcanic rocks that vary widely in hydraulic properties. Because of the low interstitial permeability in most of the rocks, groundwater moves most actively in the upper few hundred meters where fractures in the rocks are numerous and more open. Together with thick surficial mantle of vegetation and peat, shallow aquifers comprise a groundwater reservoir that responds strongly to infiltration of precipitation. Flows of most streams and levels of many of the lakes are sustained during dry periods by discharge from shallow groundwater system. Direct surface runoff of precipitation occurs frequently, however, and the quality of the surface water during these periods is influenced by salt spray from the oceans. Hydraulic tests and temperature measurements in deep drill holes show that the hydraulic head decreases with depth beneath the island. The rocks have sufficient permeability to permit slow downward flow of small amounts of fresh groundwater in response to this gradient to estimated depths of more than 1000 m where it then moves laterally and upward along an interface with saltwater to discharge at the ocean floor. The collapse of the cavity produced by the Cannikin nuclear explosion created an unsaturated rubble chimney and an area of surface subsidence now filled with water and known as Cannikin Lake. Both surface runoff and flow from the shallow groundwater system were captured for more than a year to fill the chimney voids and the lake basin. The lake and rubble chimney may have almost doubled the depth of fresh groundwater flow, allowing circulation into the rubble-filled explosion cavity. If the hydraulic properties determined by testing at this site are similar to those along a hypothetical flow path, it is estimated that water presently in the cavity could discharge to the Bering Sea within 100 years. The rate of the discharge to the Bering Sea would be extremely small, about 20 m^3/day.

26897 (TID—26712, pp 53-58) **Weather and climate.** Armstrong, R.H. (National Oceanic and Atmospheric Administration, Las Vegas, NV). Sep 1977.

In Environment of Amchitka Island, Alaska.

The following aspects of climate are discussed: temperature; low cloudiness; fog, rain, and snow; surface winds; climate of B and C sites; climate of the highlands; and solar radiation. A table is presented to show climatological data for Amchitka Island from February 1943 through June 1948. In the absence of significant local effects, such as surface heating and nocturnal cooling, which exert a large influence on weather conditions at a continental location, the weather results almost entirely from large-scale pressure systems and their associated weather fronts. (HLW)

26898 (TID—26712, pp 59-113) **Prehistoric human occupation of the Rat Islands.** McCartney, A.P. (Univ. of Arkansas, Fayetteville). Sep 1977.

In Environment of Amchitka Island, Alaska.

Prehistoric Rat Islanders had an almost exclusively marine adaptation to their island group of 10 large to small islands. A large part of the Aleut population lived on Amchitka but interacted widely within the group for subsistence and social reasons. Most previous archaeological investigations in the Rat group have been on Amchitka. Stress is placed in this chapter not on resulting artifact collections but on determinants of site location and how prehistoric Aleuts subsisted. Island size and shape, isolation, ecologic richness, and vulcanism are environmental variables thought to be important in differentiating one island from another. For any one island, such considerations as accessibility, exposure, resources, and defensibility make some coastal areas more suitable for village locations than others. Most Rat Island sites are relatively low sites with easy access to the sea. Subsistence is organized into eight major procurement systems of hunting, fishing, and gathering on open seas, littoral zones, or inland areas. These eight systems provided a stable subsistence pattern that, in turn, supported a large maritime population. Biotic variations between the Rat Islands suggest that Amchitka, Kiska, Rat, and Buldir were the most rewarding islands to exploit. Because of their primitive technology and manner of building, prehistoric Aleuts had only limited long-range impact on the islands they occupied or on the fauna and flora they utilized. Their impact on the Rat Islands was indeed small when compared with that of modern man, especially World War II personnel. Rat Island culture was similar to that developed in adjacent island groups. Conformity of artifact styles throughout the western Aleutians indicates the extensive social interaction that occurred among communities of this same area.

26899 (TID—26712, pp 141-159) **Previous scientific investigations, 1867—1967.** Fuller, R.G. (Battelle Columbus Labs., Las Vegas, NV). Sep 1977.

In Environment of Amchitka Island, Alaska.

During the first century after the United States acquired Alaska, progress in the scientific exploration of the western Aleutians was erratic. The islands were distant from the Alaskan mainland, and the Aleutian climate was a deterrent to exploration. Despite these obstacles, many investigators were drawn to the remote islands. Between 1867 and 1967 much was learned about the natural history of the western Aleutians and about the primitive peoples who inhabited the islands from prehistoric times. This body of knowledge was a useful base for planning the bioenvironmental studies reported in this volume.

26900 (TID—26712, pp 161-177) **Geomorphology.** Everett, K.R. (Ohio State Univ., Columbus). Sep 1977.

In Environment of Amchitka Island, Alaska.

Amchitka Island is composed of six distinct geomorphic regions. The major elements of each region are strongly controlled by geologic structure and to a lesser degree by rock type. The eastern three regions are characterized by pond-dotted uplands of low elevation. These are surrounded by areas of one or more elevated marine terraces. Structurally controlled drainageways cut the terraces and extend into the upland. A thick blanket of organic-rich soils forms a nearly complete mantle over the regions. Across region IV farther west, elevations rise to the mountain and plateau regions. The crest upland becomes increasingly dissected, and the blanket of organic-rich soils shows increasing signs of erosion. Much of the Pacific seacoast of regions III and IV is flanked by a broad nearly continuous intertidal platform. Region V is one of considerable relief contrast and prominently displays the effects of past glaciation, higher sea-level stands, and current mass-wasting processes. Region VI is dominated by a wind-stripped crest plateau above broad amphitheater-shaped valleys that have many features in common with the cirque-form valleys of region V. The blanket of organic-rich soils is well developed only at low elevations near the coasts.

26901 (TID—26712, pp 179-202) **Soils.** Everett, K.R. (Ohio State Univ., Columbus). Sep 1977.

In Environment of Amchitka Island, Alaska.

Three organic soils, or Histosols, are recognized on Amchitka Island which represent the suborders of Fibrists, Hemists, and Folists. The Fibrists and Folists have very restricted distribution, occupying, respectively, some of the topographically most depressed and wettest and topographically highest although not driest areas on the island. Hemists are one of the principal soils of the island. They occur as a blanket over much of the poorly drained central portions of the eastern half of the island as well as over marine terraces and other topographically low areas. Three mineral soils belonging to two soil orders are recognized. Two belong to the order Inceptisols. In terms of area, the most extensive of the Inceptistols belong to the great group of Cryaquepts. These soils are most commonly developed below 100 m (300 ft) and occupy sloping positions; they are at or near saturation for most of the year. Andic Cryaquepts occur toposequentially above the Hemists, with which they may form an association. Above the Andic Cryaquepts in the topographic moisture gradient is a hummock phase of this soil. These soils are most commonly mapped as associations. At the dry end of the toposequence are the Cryandepts. These soils are most abundant above 100 m (300 ft), especially in the mountainous and/or topographically high western half of the island, where they are commonly associated with deflation pavements and mass-movement forms. Cryopsamments, which belong to the order Entisols, occur on sandy areas (dunes). They are areally restricted but are important especially along the Bering Sea coast of the central third of the island. The soils of the island began to develop perhaps contemporaneously with

or at least soon after recession of the island's Wisconsin ice cap, approximately 10,500 years B.P.

26902 (TID—26712, pp 203-226) **Terrestrial plant ecology.** Amundsen, C.C. (Univ. of Tennessee, Knoxville). Sep 1977.

In Environment of Amchitka Island, Alaska.

Amchitka Island, near the western end of the Aleutian chain, has a maritime tundra regime that is reflected in a rather uniform meadow-like vegetation of relatively few plant taxa. The tundra vegetation exists as a continuum of types that fall into definable topoenvironmental units along a moisture gradient from fen to bog with a wind blowout—solifluction zone at higher exposed sites. The terrestrial vegetation of the island is the primary energy production source used by most of the other organisms in the island ecosystem. Local instability in soil drainage patterns, due in part to slow downslope movement of the peat-soil mantle, leads to a corresponding instability in vegetative cover in many areas. Natural revegetation of disturbed areas, which is better described as recovery than as directional secondary succession, can occur within a few years on drained organic substrates but may require a much longer time on mineral soils. Factors responsible for slow rates of recovery where vegetation has been destroyed include a lack of pioneering weedy taxa, frost heaving, lateral instability of the substrates, low availability of seeds or other propagules, and a generally depauperate island flora.

26903 (TID—26712, pp 227-260) **Avifaunal investigations.** White, C.M. (Brigham Young Univ., Provo, UT); Williamson, F.S.L.; Emison, W.B. Sep 1977.

In Environment of Amchitka Island, Alaska.

Bird populations on and near Amchitka, Alaska, were studied between 1967 and 1973 to determine species composition, ecological distribution, density, productivity, and seasonal movements. Since 1955, 131 species have been recorded there, and evidence of breeding was obtained for 28 of these. Fourteen ecological formations, based on characteristics of vegetation and physical features of the environment, were used to analyze the distribution of birds. Various species or groups of birds were studied to determine population densities and, in some cases, food habits. Marine littoral waters, sea beaches, Empetrum—Cladonia tundra, pelagic waters, and lacustrine waters, in that order, showed the greatest use by birds, and any one of these was used by nearly twice as many species as any one of the other nine formations. The Lapland Longspur had the greatest density of the breeding birds, about one pair per acre in riparian meadow habitat, and made up over one-half of all breeding birds. Waterfowl were conspicuous elements of the avifauna, but, although there are more than 2500 lakes on Amchitka, less than 1% were used by fall and winter flocks. The perimeter of the island was used rather uniformly by breeding Bald Eagles and Peregrine Falcons, whereas cormorant colonies were less uniformly distributed. Many species were resident, but most spring migrants arrived rather suddenly. The onset of nesting was delayed in some species, although considerable synchrony was manifest in most breeding phenologies. The prime species affinity was holarctic, and the dearth of passerines reflected the disharmonic (biologically unbalanced) nature of the avifauna characteristic of many islands.

26904 (TID—26712, pp 261-267) **Status of the Norway rat.** Brechbill, R.A. (Energy Research and Development Administration, Las Vegas, NV). Sep 1977.

In Environment of Amchitka Island, Alaska.

Since the introduction of the Norway rat, Rattus norvegicus, to Amchitka Island, Alaska, during World War II, the species has become an established part of the island's fauna. Taxonomic identification indicates that the Norway rat is the only species of rat on the island. Population density is high in the beach areas and sparse inland. The environmental implications of the colonization of rats on Amchitka are difficult to determine because of the lack of base-line information before their introduction and the paucity of studies since.

CHEMICALS MONITORING AND TRANSPORT

REFER ALSO TO CITATION(S) 25949, 26870, 26875, 26880, 26885, 27003

26905 (AD-A—043713) **Contingency planning for the impact of oil spills in different coastal environments of Canada. Technical report.** Owens, E.H. (Louisiana State Univ., Baton Rouge (USA). Coastal Studies Inst.). Dec 1977. Contract N00014-75-C-0192. 11p.

Planning for a cleanup operation of the shore zone requires consideration of the physical nature of the coast (including the sediment types), wave energy levels, and tidal range. Beaches exist in a dynamic state and are continuously changing in response to littoral processes. In addition to these temporal variations, there is frequently considerable variability of shoreline types and process characteristics within a small region. In eastern Canada, contingency planning must cover rocky shorelines, sand beaches, and muddy coasts. There also is a wide range of littoral process environments, from the exposed Atlantic coast to the sheltered Bay of Fundy, which has tidal ranges on the order of 10 to 15 meters. Three examples from eastern Canada illustrate the variability of shorelines and processes in the context of cleanup planning. (Author)

26906 (TID—26712, pp 615-625) **Polychlorinated biphenyls in the ecosystems.** White, C.M. (Brigham Young Univ., Provo, UT); Risebrough, R.W. Sep 1977.

In Environment of Amchitka Island, Alaska.

Chemical residues in the form of DDE and polychlorinated biphenyls (PCB) from 21 species taken from Amchitka environs between 1970 and 1974 were identified and quantified. These samples were from birds, mammals, and fish and represented carnivores, herbivores, and omnivores, and both the aquatic and terrestrial ecosystems. The levels of DDE and PCB were then compared with ecological equivalents of the same or similar species in other parts of the Aleutians and Pacific Basin. The Amchitka samples generally had higher residue levels than ecological equivalents in the Southern Hemisphere, and carnivores were generally higher than other types. The sources of these pollutants found in the Amchitka region are discussed. Current levels of DDE and PCB are not high enough in the Amchitka ecosystem to be of prime concern or to impair reproduction. They are, however, higher than would be expected for the remoteness of the island from sources of pollutants and bear careful monitoring.

26907 (TID—26712, pp 627-649) **Ecological consequences of nuclear testing.** Fuller, R.G. (Battelle Columbus Labs., Las Vegas, NV); Kirkwood, J.B. Sep 1977.

In Environment of Amchitka Island, Alaska.

Many of the terrestrial disturbances on Amchitka Island resulting from nuclear testing were superimposed on scars remaining from military occupation. Construction, road improvement, and the Milrow and Cannikin nuclear detonations resulted in the loss or deterioration of about 420 ha (1040 acres) of terrestrial habitat, or less than 1.5% of the total area of Amchitka. A few streams and lakes were polluted by drilling effluents or human wastes; normal flushing action is expected to restore the quality of most of these freshwater habitats. Irreversible effects in freshwaters include the drainage of several ponds, gross channel alteration in a part of one stream, and the creation of a new lake which is deeper and which has a greater volume than any of the more than 2100 natural lakes on the southeast half of Amchitka. About 6 ha (15 acres) of intertidal bench was displaced to a level above the intertidal zone, and an undetermined amount of similar habitat was altered to some degree by lesser vertical displacement. No type of habitat on the island was destroyed, and localized habitat losses in the terrestrial, freshwater, and marine ecosystems are believed to have been too slight to have permanent effects on associated biotic populations.

RADIOACTIVE MATERIALS MONITORING AND TRANSPORT

REFER ALSO TO CITATION(S) 25943, 25944, 25949, 25951, 26873, 26889, 26895, 26907, 26934, 26989

26908 (PNL—2454) **Revegetation of a waste disposal site in the 200 areas of the Hanford Reservation.** Cline, J.F.; Uresk, V.A. (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). Nov 1977. Contract EY-76-C-06-1830. 22p. Dep. NTIS, PC A02/MF A01.

The purpose of the experiment was to test and compare the efficacy of various soil amendments in establishing a self-sustaining vegetative cover on soil fill overlying a portion of a former radioactive waste pond. Data are presented for content of ^{90}Sr, ^{106}Ru, ^{137}Cs, U, and Pu in the pond, percent frequency of occurrence of cheatgrass, rye, Russian thistle, bursage, and tansy mustard for three growing seasons; biomass summary by species from the treatments of straw, clay, and control; chemical analysis of young leaf tissue of cheatgrass; length, width, height, and volume measurements of mature Russian thistle plants; ^{90}Sr content of Russian thistle plants; and vegetative composition of black-tailed hare fecal pellets. (HLN)

SOIL

26909 (NVO—171) **Environmental plutonium on the Nevada Test Site and environs.** White, M.G.; Dunaway, P.B.; Howard, W.A. (eds.). (Energy Research and Development Administration, Las Vegas, Nev. (USA). Nevada Operations Office). Jun 1977. 329p. (CONF-760210—). Dep. NTIS, PC A11/MF A01.

From Nevada applied ecology group plutonium and other transuranics information conference; Las Vegas, NV, USA (12 Feb 1976).

Separate abstracts were prepared for the sections of this report on transuranium element transport in terrestrial ecosystems of Nevada Test Site and the Tonopah Test Range.

26910 (NVO—171, pp 1-15) **Plutonium distribution in a desert pavement-desert mound soil system in area 11.** Tamura, T. (Oak Ridge National Lab., TN). Jun 1977.

From Nevada applied ecology group plutonium and other transuranics information conference; Las Vegas, NV, USA (12 Feb 1976).

In Environmental plutonium on the Nevada Test Site and environs.

This interim report presents data on ^{238}Pu, ^{239}Pu, ^{240}Pu, and ^{241}Am distribution in a desert pavement desert-mount soil system in Area 11 of the Nevada Test Site. Total plutonium soil concentrations with depth, plutonium concentrations in the different particle size classes, and preliminary information on plutonium distribution as a function of mineral density fractions are included.

26911 (NVO—171, pp 227-236) **Plutonium distribution in the environs of the Nevada Test Site: status report.** Bliss, W.A.; Jakubowski, F.M. (Environmental Protection Agency, Las Vegas, NV). Jun 1977.

From Nevada applied ecology group plutonium and other transuranics information conference; Las Vegas, NV, USA (12 Feb 1976).

In Environmental plutonium on the Nevada Test Site and environs.

Over 6,000 soil samples from Areas 1, 4, and 5 of the Nevada Test Site were Ge(Li) scanned for Am-241 and other gamma-emitting radionuclides. The results indicate only about 5% contained Am-241 in quantities above the detection limit (1 pCi/g of Am-241). In addition, approximately 10% of the samples were subjected to wet chemistry analysis for Pu-239. The results indicate all contained Pu-239 in quantities above the detection limit (0.01 pCi/g of Pu-239). The largest concentrations of Am-241 and Pu-239 appear in the Hamilton and Small Boy sites of Area 5. The Hamilton soil data may be sufficient to estimate both an inventory and a distribution of plutonium over most of the site, but the data from the majority of the other sites are sufficient only to set upper limits of plutonium inventories.

26912 (NVO—171, pp 237-274) **Initial synthesis of area 13 ^{239}Pu data and other statistical analyses.** Gilbert, R.O. (Battelle Memorial Inst., Richland, WA); Eberhardt, L.L.; Smith, D.D. Jun 1977.

From Nevada applied ecology group plutonium and other transuranics information conference; Las Vegas, NV, USA (12 Feb 1976).

In Environmental plutonium on the Nevada Test Site and environs.

An initial synthesis of the /sup 239,240/Pu concentration data currently available from Area 13 on the Nevada Test Site for soil, vegetation, small mammals, and grazing cattle is presented. For the most part, this synthesis has consisted of simple visual comparisons between different trophic levels by plotting all the data on a single graph. The soil and vegetation data are seen to be highly variable within strata, but with strata means increasing with increasing proximity to GZ. This large variability also exists in small mammal tissue concentrations. There is a lack of correlation between rodent concentrations and concentrations in the soil where animals live, due perhaps in part to the mobility of rodents. /sup 239,240/Pu concentrations in cattle tissue are also plotted and compared with other tropic levels. These comparisons are hampered by the small number of cattle tissue samples available for statistical analysis.

TERRESTRIAL ECOSYSTEMS AND FOOD CHAINS

REFER ALSO TO CITATION(S) 25947, 25948, 25950, 26909, 26912

26913 (NVO—171, pp 35-119) **Estimated inventory of plutonium and uranium radionuclides for vegetation in aged fallout areas.** Romney, E.M. (Univ. of California, Los Angeles); Wallace, A.; Kinnear, J.; Gilbert, R.O. Jun 1977.

From Nevada applied ecology group plutonium and other transuranics information conference; Las Vegas, NV, USA (12 Feb 1976).

In Environmental plutonium on the Nevada Test Site and environs.

Data are presented pertinent to the contamination of vegetation by plutonium and other radionuclides in aged fallout areas on the Nevada Test Site (NTS) and the Tonopah Test Range (TTR). The standing biomass of vegetation estimated by nondestructive dimensional methods varied from about 200 to 600 g/m^2 for the different fallout areas. Estimated inventories of ^{238}Pu, ^{239}Pu, ^{240}Pu, and ^{235}U in plants and their biological effects are discussed.

26914 (NVO—171, pp 121-192) **Solubility of plutonium and americium-241 from rumen contents of cattle grazing on plutonium-contaminated desert vegetation in in vitro bovine gastrointestinal fluids, November 1974—May 1975.** Barth, J. (Environmental Protection Agency, Las Vegas, NV). Jun 1977.

From Nevada applied ecology group plutonium and other transuranics information conference; Las Vegas, NV, USA (12 Feb 1976).

In Environmental plutonium on the Nevada Test Site and environs.

The uptake of ^{238}Pu, ^{239}Pu, and ^{241}Am by cattle through ingestion of contaminated forage at the Nevada Test Site and the Rocky Flats Plant are compared. Data are included on the solubility of ^{239}Pu and ^{241}Am by bovine gastrointestinal fluids, the effects of particle size on the retention of sand in the gastrointestinal tract of ruminants, the tissue distribution of ^{238}Pu, and ^{243}Cm in lactating dairy cows, with emphasis on excretion in milk.

26915 (NVO—171, pp 193-217) **^{239}Pu and ^{241}Am contamination of small vertebrates in NAEG study areas of NTS and TTR.** Moor, K.S.; Naele, S.R.; Bradley, W.G. (Univ. of Nevada, Las Vegas). Jun 1977.

From Nevada applied ecology group plutonium and other transuranics information conference; Las Vegas, NV, USA (12 Feb 1976).

In Environmental plutonium on the Nevada Test Site and environs.

Ecological studies of small vertebrates in three plutonium (Pu) contaminated study areas of Nevada Test Site began in Spring, 1972, and were expanded to include four areas of Tonopah Test Range in Fall, 1973. This report consists primarily of presentation and analysis of radioanalytical data on rodents and lizards from Area 11-C, Nevada Test Site. In addition, methodology and preliminary results of initial hematologic studies are presented. Dipodomys microps is a dominant rodent species in all study areas. Concentrations of ^{239}Pu and ^{241}Am in pelt, GI tract, and carcass of 74 resident D. microps from five study areas were determined. The only consistent trend evident was that carcass burdens were lower than pelt or GI tract burdens by a factor of 10^2. Mean ratios of Pu/Am in tissue aliquots were variable, and many were significantly different than ratios in soil or vegetation samples.

26916 (NVO—171, pp 219-226) **Influence of microbial activities on availability and biotransport of plutonium.** Au, F.H.F.; Beckert, W.F. (Environmental Protection Agency, Las Vegas, NV). Jun 1977.

From Nevada applied ecology group plutonium and other transuranics information conference; Las Vegas, NV, USA (12 Feb 1976).

In Environmental plutonium on the Nevada Test Site and environs.

The effects of native vegetation and agricultural practices on soil microbial populations and the probable effects of changes in these microbial populations on the bioavailability and transport of plutonium to plants are discussed. The biological movement of transuranics in soil systems is reviewed. A special technique developed for these studies to collect small particles is briefly outlined. The use of this technique, which eliminated cross-contamination problems, made possible uptake studies with various plutonium compounds using the soil fungus Aspergillus niger. The same technique is applicable to various phases of ongoing studies. Experiments currently in progress are designed to elucidate the roles of various common soil microorganisms on the movement of transuranics in soil and on the bioavailability of transuranics to plant and animals.

SITE RESOURCE AND USE STUDIES

REFER ALSO TO CITATION(S) 25686

26917 (LA—6975-M) **GMAPS user's manual.** Wecksung, M.J.; Wiley, R.A.; Turner, A.K. (Los Alamos Scientific Lab., N.Mex. (USA)). Jan 1978. Contract W-7405-ENG-36. 50p. Dep. NTIS, PC A03/MF A01.

Land-use planners involved in siting analyses must make complex decisions based on their in-depth knowledge of numerous factors. These factors include resource location, accessibility to transportation corridors, and legal, social, and environmental constraints. The General Map Analyses Planning System (GMAPS) is a composite computer mapping system designed to assist the planning team in making these decisions rapidly and efficiently. GMAPS allows the user to define a series of different scenarios and to investigate quickly a wide range of planning alternatives. It is a remote-access interactive system that can be operated by nontechnical personnel from portable terminals at field offices. 11 figures, 1 table.

26918 (NTIS/PS—77/0950) **Strip mining. Volume I. 1964-1975 (citations from the NTIS data base). Report for 1964—75.** Hunde-

mann, A.S. (National Technical Information Service, Springfield, Va. (USA)). Nov 1977. 161p. NTIS PC N01/MF N01.

Abstracts primarily pertaining to environmental impacts, land reclamation, and satellite remote sensing of mines are cited. A few abstracts deal with mining equipment, legal factors, economics, and safety aspects of strip mining. (This updated bibliography contains 156 abstracts, none of which are new entries to the previous edition.)

26919 (NTIS/PS—77/0951) **Strip mining. Volume 2. 1976-October 1977 (citations from the NTIS data base). Report for 1976-Oct 77.** Hundemann, A.S. (National Technical Information Service, Springfield, Va. (USA)). Nov 1977. 136p. NTIS PC N01/MF N01.

Abstracts primarily pertaining to environmental impacts, land reclamation, and satellite remote sensing of mines are cited from Federally-funded research. A few abstracts deal with mining equipment, legal factors, economics, and safety aspects of strip mining. (This updated bibliography contains 131 abstracts, 81 of which are new entries to the previous edition.)

26920 (PB—273463) **Aquatic and terrestrial surveys in the vicinity of power plants using remote sensing. Final report.** Schott, J.R.; Gaucher, D.W. (Calspan Corp., Buffalo, N.Y. (USA)). 15 Apr 1977. 66p. (CALSPAN-NA—6019-M-2). NTIS PC A05/MF A01.

This report discusses a program to assess the potentials of aerial 'photometric' interpretation in evaluating impact. The intent of the program was to see to what extent the reflectance properties of elements in the environment as measured from aerial photography could be related to the condition of the environment. In studies around fossil fueled power plants, selected sites were ranked to levels of air pollution induced stress based on field observation of foliage. The reflectances of these same areas were measured using Calspan's aerial photometric analysis techniques. Results of this program indicate that vegetative stress in a forested environment as defined by field observations can be related to reflectance signatures as measured from aerial imagery. (Color illustrations reproduced in black and white)

REGULATIONS

REFER ALSO TO CITATION(S) 26891, 26892

26921 (E—77-10184) **Application of Landsat-2 data to the implementation and enforcement of the Pennsylvania Surface Mining Conservation and Reclamation Act. Final report, March 1975—May 1977.** Russell, O.R.; Nichols, D.A.; Anderson, R. (Earth Satellite Corp., Washington, D.C. (USA)). May 1977. Contract NAS5-21998. 78p. NTIS PC A05/MF A01.

The author has identified the following significant results. Evaluation of LANDSAT imagery indicates severe limitations in its utility for surface mine land studies. Image stripping resulting from unequal detector response on satellite degrades the image quality to the extent that images of scales larger than 1:125,000 are of limited value for manual interpretation. Computer processing of LANDSAT data to improve image quality is essential; the removal of scanline stripping and enhancement of mine land reflectance data combined with color composite printing permits useful photographic enlargements to approximately 1:60,000.

26922 (TID—26712, pp 115-140) **History, 1741—1967.** Merritt, M.L. (Sandia Labs., Albuquerque, NM). Sep 1977.

In Environment of Amchitka Island, Alaska.

Amchitka has long been subject to man's influence. When discovered by the Russians in 1741, the Aleutians had 10,000 to 20,000 inhabitants and Amchitka itself perhaps 100. Hard treatment caused their number to fall drastically, and by 1849 Amchitka was abandoned. No one has lived there on a permanent basis since, but old living sites are still visible around the edges of the island. Pressure by Russian and American hunters led to the near extermination of sea otters, conservation measures not having been kept up after the 1867 purchase; the 1911 Fur Seal Treaty, however, served also to protect sea otters, and they have recovered well. In 1913 the Aleutians were set aside as what is now called the Aleutian Islands National Wildlife Refuge. In 1921 blue foxes were introduced onto Amchitka for support of Aleuts from Atka. As a result the Aleutian Canada Goose was extirpated from the island. The foxes themselves were finally eradicated from the island by 1960 by an extensive poisoning program. During World War II Amchitka became the forward fighter-bomber base in the campaign against Japanese-held Attu and Kiska. About 5000 troops were present on the island then, and facilities were later added to house an authorized troop strength of about 16,000. Many structures, roads, three airstrips, and much miscellaneous debris remain from the war years. In 1965, 1969, and 1971, nuclear shots were fired underground at Amchitka by the U.S. Department of Defense and the U.S. Atomic Energy Commission. During the first of these, there was a small bioenvironmental program, and, during the last two, a large one, the results of which are reported in other chapters of this book.

ENVIRONMENTAL SCIENCES, AQUATIC

REFER ALSO TO CITATION(S) 26413, 26990

BASIC STUDIES

REFER ALSO TO CITATION(S) 26893, 26894, 26895, 26896, 26897, 26899, 26903, 26942, 26970, 27004, 27005, 27021

26923 (TID—26712, pp 269-286) **Limnology.** Burkett, R.D. (Battelle Columbus Labs., OH). Sep 1977.

In Environment of Amchitka Island, Alaska.

Limnological studies were conducted from 1967 to 1974 to collect and interpret data necessary for classifying the aquatic ecosystems of Amchitka Island according to their physical, chemical, and biological features. Initial surveys were followed by intensive study of lakes and streams selected for analysis of test-related effects. Pertinent limnological data were obtained from these aquatic systems to assist in the evaluation of the effects of Atomic Energy Commission operations on the surrounding environs. Investigations included physical and chemical characteristics of the waters, analysis of both phytoplankton and zooplankton communities, and rate measurements of algal photosynthesis and heterotrophic activity. The pH of the freshwaters on Amchitka ranges from acidic to alkaline, usually between 6.0 and 8.0. Alkalinities in the range of 10 to 20 mg $CaCO_3$/liter are common. Of the principal elements, sodium and chlorine were found at high concentrations, a manifestation, no doubt, of wind-carried sea spray. Phosphate was judged to be limiting algal photosynthesis in some lakes. Carbon fixation rates ranging from less than 1.0 to 119 mg C m^{-3} hr^{-1} were recorded. Most of the lakes support a diverse phytoplankton composition. The most productive lakes contain large populations of Cyanophyta. Rotifers, primarily Keratella quadrata, were the dominant zooplankters and were distributed widely over the island. Copepods occurred sporadically, and cladocerans were commonly absent. Most of the lakes studied have an autochthonous supply of organic material. Heterotrophic activity was correlated to total organic-matter concentration in the lake waters. Ground shock waves had little effect on the parameters studied. The most serious perturbations resulted from the influx of drill mud to several aquatic habitats.

26924 (TID—26712, pp 287-313) **Aquatic ecology.** Valdez, R.A.; Helm, W.T.; Neuhold, J.M. (Utah State Univ., Logan). Sep 1977.

In Environment of Amchitka Island, Alaska.

The freshwater ponds and streams of Amchitka support few species of vertebrates and invertebrates. Aquatic community structure is therefore simple, and only three major trophic levels can be recognized: primary producers (benthic periphyton and vascular plants), primary consumers (invertebrates), and secondary consumers (fishes). Production by periphyton and vascular plants in streams is low. Most of the streams are evidently heterotrophic since the shower of detritus from streamside and pond vegetation exceeds that produced in the channel. Immature insects, particularly midges, use this organic matter and serve as the principal food of Dolly Varden, threespine stickleback coast-range sculpin, and immature silver salmon. Pink salmon and occasionally sockeye salmon also use the island streams for spawning. The two underground nuclear detonations, Milrow and Cannikin, had profound effects on those ponds and streams within about 2 km of surface zero (SZ). Ponds were drained by fissuring or tilting, and stream channels were altered. Local fish populations suffered from these terrain alterations and from pressure waves generated by the blasts. Extensive effects on freshwater communities were observed before these events, when the emplacement shafts were being drilled. Mud spills from the drilling operations released hazardous chemicals and heavy particulates into nearby streams, which decimated fish and invertebrate populations. The invertebrates were killed by the concentration of petroleum products and by the suffocating effects of compacted muds. The fish populations failed because of the chemicals and muds as well as the reduction of their principal food source, the midges. Once the mud spills abated, flushing action in the short streams enhanced the expulsion of the drilling muds.

26925 (TID—26712, pp 353-393) **Ecology of marine algae.** Lebednik, P.A.; Palmisano, J.F. (Univ. of Washington, Seattle). Sep 1977.

In Environment of Amchitka Island, Alaska.

The rocky shores of Amchitka Island are densely carpeted by marine algal communities, which, beyond the coast exposed by the tides, are characterized by extensive floating kelp beds. An unusual feature of the intertidal area of the southeastern third of the island is the occurrence of wide, often extremely flat, rock benches at about mean tide level. The littoral region is characterized by a supralittoral

fringe area with Prasiola, Rhodochorton, and Porphyra—Ulothrix zones and a midlittoral area with Fucus, Hedophyllum, and Alaria zones. Many species distributions are strongly influenced by the benches, being correlated with horizontal distance perpendicular to the shore. The presence of Hedophyllum and Fucus zones indicates more protected conditions than might have been expected. It is suggested that the bench topography and offshore kelp beds provide an exposure gradient across the intertidal area. The Milrow nuclear test affected about 4 ha (10 acres) of littoral vegetation when an uplift of about 12 cm (5 in.) occurred on an intertidal rock bench. Mortality was extensive in the upper portions of all zones 6 months after the disturbance, and significant changes were still occurring when last observed, 3½ years after Milrow. The Cannikin nuclear test resulted in uplifting up to a maximum of 1 m (3 ft). Mortality of littoral vegetation was severe along 1.9 km (1.2 miles) of coast, including areas with 0.5 to 1 m of uplift. Moderate mortality was observed along an additional 1.5 km (1 mile) of coast, and mortality was detectable along a further 2.7 km (1.7 miles) of coast. Significant changes in vegetation were reported to be occurring nearly 3 years after Cannikin. A normal littoral vegetation will eventually return to both the Milrow- and Cannikin-disturbed areas.

26926 (TID—26712, pp 395-449) **Marine invertebrates in rocky intertidal communities.** O'Clair, C.E. (Univ. of Washington, Seattle). Sep 1977.

In Environment of Amchitka Island, Alaska.

Previous knowledge of Aleutian marine benthic invertebrates was based on few observations and collections, the history of which is summarized. In this study three belt transects (one sampled once and two sampled seven times) and two intertidal arrays (sampled twice each) of 0.25-m^2 quadrats were used for descriptive studies of intertidal communities at Amchitka Island. These communities are dominated by algae at all tidal levels. Three communities designated according to their dominant macrophytes are the Laminaria community, the Alaria—Hedophyllum community, and the Halosaccion-Fucus community. Invertebrates in these communities are mostly inconspicuous. Despite the large proportion of North American species in the fauna of Amchitka, species that play key roles in structuring intertidal communities elsewhere on the west coast of North America are absent or in low abundance at Amchitka. Invertebrates in subtidal communities are discussed briefly. An annotated list of over 365 littoral and sublittoral invertebrate species is appended. Seven zoogeographical elements were recognized in the shallow-water marine fauna of Amchitka. The greatest proportion of species are North Pacific or North American in their distribution. Two oceanographic features (the Alaskan Stream and the Kamchatka Current) and one geologic feature (the Aleutian "stepping-stone" islands between Amchitka and the Asian and North American mainlands) increase the immigration rates of North American species over Asiatic species. The effects of Cannikin were determined with the use of two intertidal arrays of fixed 0.25-m^2 quadrats (totaling 40 plots) examined twice preevent and ten times postevent (over 33 months) and an intertidal grid (control) sampled randomly once preevent and twice (over 9 months) postevent.

26927 (TID—26712, pp 451-492) **Marine fish communities.** Simenstad, C.A.; Isakson, J.S.; Nakatani, R.E. (Univ. of Washington, Seattle). Sep 1977.

In Environment of Amchitka Island, Alaska.

Intensive multiple-gear sampling of the fish fauna occupying the marine waters adjacent to Amchitka Island showed 92 fish species distributed over seven basic communities according to their characteristic habitats--littoral, inshore/rock—algae, inshore/sand—gravel, offshore demersal/rock—sponge, offshore demersal/sand—gravel, epipelagic, and mesopelagic. Recurrent group analysis disclosed 13 statistically distinct species associations within five of these communities as well as several distinct predator—prey relationships. North American species predominated in the composition of the fish fauna, which reflects the principal dispersal role of the Alaska Stream current, which flows westward about Amchitka. Benthipelagic amphipods and mysids are the predominant prey ogranisms, and both serve a major role in the transfer of algae-based detritus to the inshore fish communities; euphausiids contribute similarly to offshore fish communities. The Pacific sand lance appears to be a significant importer of offshore-derived zooplankton biomass into the inshore fish communities. Among the three underground nuclear tests at Amchitka, Cannikin produced the most significant impact by kills of several fish species and changes in habitat through uplifting of some littoral rock benches. Although the recovery of the affected fish communities appeared to be complete within a year, the habitat and prey resources formerly provided by the bench that is now uplifted will remain unavailable for many years.

26928 (TID—26712, pp 527-567) **Ecological interactions involving the sea otter.** Palmisano, J.F.; Estes, J.A. (Univ. of Washington, Seattle). Sep 1977.

In Environment of Amchitka Island, Alaska.

A comparison of western Aleutian Islands with and without sea otters shows this species to be important to the organization of the nearshore communities. Sea otters control herbivorous invertebrate populations and indirectly affect wave exposure and the composition of the rocky intertidal community. The removal of sea otters causes increased herbivory and ultimately results in destruction of macrophyte associations. Our observations suggest that a dense sea otter population indirectly supports fauna associated with macrophyte primary productivity.

CHEMICALS MONITORING AND TRANSPORT

REFER ALSO TO CITATION(S) 25644, 25798, 26011, 26870, 26871, 26873, 26874, 26875, 26878, 26885, 26906, 26907, 26920, 27003

26929 (AD-A—042365) **Development of additional hazard assessment models. Final technical report.** Raj, P.P.K.; O'Farrel, P.M. (Little (Arthur D.), Inc., Cambridge, Mass. (USA)). Mar 1977. Contract DOT-CG-24655-A. 312p. (ADL—74685-3). NTIS PC A14/MF A01.

Five additional assessment models have been developed to delineate the hazards caused by chemicals with specific properties when they are accidentally released in different environmental conditions. These models describe the sinking, spreading and dissolution of heavy liquids in a river, dissolution of heavier than water low boiling point liquids released underwater, spreading on water of continuously released oil (including experimental results) and cryogenic liquids, and the release of chemicals that react with water. The heating by fire and consequent rupture of a propylene barge tanks is also investigated. (Author)

26930 (COO—3566-19) **Distribution of some chemical elements between dissolved and particulate phases in the ocean. Period covered: August 1, 1976—October 31, 1977.** Spencer, D.W.; Brewer, P.G.; Bacon, M.P.; Sachs, P.L.; Smith, C.L.; Fleer, A.; Kadar, S. (Woods Hole Oceanographic Institution, Mass. (USA)). 1977. Contract EY-76-S-02-3566. 74p. NTIS, MF A01.

Portions of document are illegible.

Progress is reported on studies of the distribution of dissolved and particulate forms of naturally radioactive ^{210}Pb and ^{210}Po in ocean coastal waters, deep waters, and the continental shelf and slope. Data are included from measurements of ^{210}Pb and ^{210}Po in seawater and sediment samples collected in the Labrador Sea area, the North Sea, the Norwegian Sea, and the Iceland-Scotish Overflow area of the North Atlantic Ocean.

26931 (NTIS/PS—77/0949) **Acid mine drainage (a bibliography with abstracts). Report for 1964-Nov 77.** Brown, R.J. (National Technical Information Service, Springfield, Va. (USA)). Nov 1977. 225p. NTIS PC N01/MF N01.

The bibliography on acid mine drainage cites studies primarily concerning control and treatment methods. Reports on hydrogeology, ecology, formation, and sources are included. (This updated bibliography contains 220 abstracts, 36 of which are new entries to the previous edition.)

26932 (ORNL/TM—6098) **Nationwide assessment of water quantity impacts of the National Energy Plan. Volume I. Summary and conclusions.** Dobson, J.E.; Shepherd, A.D.; Palmer, R.G.; Chiu, S. (Oak Ridge National Lab., Tenn. (USA)). Dec 1977. Contract W-7405-ENG-26. 69p. (ORNL/OEPA—3). Dep. NTIS, PC A04/MF A01.

The water requirements of steam electric generating plants, coal liquefaction and gasification facilities, and coal extraction activities projected for 1985 are calculated, and impacts associated with the National Energy Plan (NEP) Initiative are compared with those of a Base Case Scenario for the conterminous United States. It can be concluded that there is no appreciable difference in water quantity impacts at the Water Resources Council Aggregated Subarea (ASA) level. Consumption as a percentage of the surface supply never varies by more than one percent between the two scenarios except for the Trinity Basin of Texas, and most of the differences are reductions from the Base Case to the NEP. However, for either case there will be a considerable increase in water use for energy between 1975 and 1985, and water availability may constrain development in several basins of the western United States. Even in the humid eastern United States localized water problems may occur on certain small tributaries.

RADIOACTIVE MATERIALS MONITORING AND TRANSPORT

REFER ALSO TO CITATION(S) 25943, 25944, 26871, 26873, 26889, 26895, 26907

26933 (AD-A—046203) **Decontamination of water containing chemical and radiological warfare agents by reverse osmosis. Technical report Jul—Nov 76.** Lindsten, D.C.; DesRoches, P.R. (Army Mobility Equipment Research and Development Center, Fort Belvoir, Va. (USA)). Jun 1977. 57p. (MERADCOM—2211). NTIS PC A04/MF A01.

This report describes a study evaluating an advanced engineering development model 600 gal/h Reverse Osmosis (RO) Water Purification Unit for decontaminating water containing chemical warfare (CW) and radiological warfare (RW) agents. The study was conducted in implementation of a ROC 'Family of Water Supply Equipment' approved by DA on 4 March 1974 defining the requirements for a multipurpose water purifier capable of providing potable water from polluted fresh water, seawater, brackish water, and water contaminated with chemical, biological, and radiological agents. Three different chemical agents (GB, VX, BZ) and three different radiological agents (131)I, (85)Sr, (134)Cs) were used. The RO unit was employed with two types of RO membrane: brackish water, dry storage, cellulose acetate (CA) membrane; and seawater, dry storage, polyamide (PA) membrane. The results of the study indicated that both membranes effectively removed turbidity, conductivity, color, alkalinity, hardness, and dissolved solids from water. In the case of the six CW and RW contaminants, the PA membrane proved to be consistently superior to the CA membrane. However, even the PA membrane was not always successful in reducing the contaminant concentration to Maximum, Permissible Concentration (MPC) or below.

26934 (TID—26712, pp 579-613) **Radionuclides in air, water, and biota.** Seymour, A.H.; Nelson, V.A. (Univ. of Washington, Seattle). Sep 1977.

In Environment of Amchitka Island, Alaska.

Air, water, and biological samples collected before and after the 1965, 1969, and 1971 underground nuclear detonations at Amchitka Island were analyzed for natural and fallout radionuclides by gamma spectrometry. Selected samples were also analyzed for tritium, ^{55}Fe, and ^{90}Sr. The objectives were to search for and identify radionuclides of Amchitka origin in the samples and to contribute to the general knowledge of the distribution of radionuclides in the environment. The studies showed that there has been no escape of radionuclides from the underground sites of the three nuclear detonations at Amchitka Island except for trace quantities of radionuclides, principally tritium, in water and soil gas samples from the immediate vicinity of the surface ground zero for the 1965 event. Two naturally occurring radionuclides, ^{40}K and ^{7}Be, were the most abundant radionuclides in the samples, usually by a factor of 10 or more, except for ^{137}Cs in lichen samples. All levels were well below applicable Radiation Protction Guides, often being near the statistical limit of detection.

AQUATIC ECOSYSTEMS AND FOOD CHAINS

REFER ALSO TO CITATION(S) 25948, 26992

THERMAL EFFLUENTS MONITORING AND TRANSPORT

26935 (PB—273468) **Phenomenological models for prediction of water temperatures due to thermal-electric power plant heated discharges. Final report.** Cataldo, J.C.; Goodman, A.S. (Polytechnic Inst. of Brooklyn, N.Y. (USA)). Aug 1977. 91p. NTIS PC A05/MF A01.

A phenomenological model has been developed for the prediction of far field sub-surface temperatures from a given set of surface isotherms due to heated effluent discharge from a thermal-electric power plant. When surface isotherms are obtained from infrared overflight measurements, the model can provide estimates of subsurface isotherms. The model accuracy was verified by predicting over 1300 subsurface temperatures at eight different power plants. A comprehensive set of insitu triaxial temperature measurements were obtained for each power plant studied. The average difference between the predicted temperatures and measured temperatures was less than 0.20C. The following power plant discharges and receiving water conditions were considered: Surface and subsurface discharges; shallow lake and deep estuary environment; zero, mild and strong parallel to shore currents. For given categories of surface and subsurface discharges a series of exponential equations relating the surface areas and center line distances to the sub-surface areas and center line distances were developed to predict subsurface temperatures down to 23 feet below the surface.

SITE RESOURCE AND USE STUDIES

REFER ALSO TO CITATION(S) 26505, 26918, 26919

26936 (PB—273603) **Potential environmental impact of compounding and fabricating industries: a preliminary assessment. Final report.** Clark, R.; Burch, J.; Ayers, R.; Brown, D.; Dick, R. (Battelle Columbus Labs., Ohio (USA)). Aug 1977. Contract EPA-68-02-1323. 299p. NTIS PC A13/MF A01.

The overall objectives of this research effort were to identify compounding and fabricating industries from a selected number of Standard Industrial Classification codes, and identify the environmental impact resulting from processing steps used by fabrication or compounding industries. Industries in the United States fall into two basic categories -- those that process primary raw material such as iron ore, logs, silica sand, animal hide, etc., and those that fabricate or compound these raw materials into various consumer goods. This report assesses the potential environmental impact of industries in the second category, the compounding and fabricating industries. The basic approach was to classify each industry by type and major unit processes supported, and then to characterize the waste streams produced by the unit processes. Examples of industries that are classified as compounding and fabricating industries are the automobile industry and the surface coating industry. (Portions of this document are not fully legible)

REGULATIONS

REFER ALSO TO CITATION(S) 26922

26937 (TID—26712, pp 315-330) **Fishery resources of the western Aleutians.** Merrell, T.R. Jr. (National Oceanic and Atmospheric Administration, Auke Bay, AK). Sep 1977.

In Environment of Amchitka Island, Alaska.

The fishery resources in the western Aleutian Islands are diverse, abundant, and heavily exploited, primarily by Japanese and Soviet fishermen. Seven groups make up the bulk of the current catch: salmon (sockeye, chum, and pink), king crabs, Pacific halibut, Pacific ocean perch, sablefish, walleye pollock, and Pacific cod. Three species of whales (sperm, fin, and sei) are also captured. The marine environment is highly productive and is relatively unaffected by man's activities other than fishing. Prospects for continued or expanded fishery harvests vary according to species. Pink and chum salmon stocks will probably remain at about current levels. Sockeye stocks will probably recover somewhat from their present low levels if average environmental conditions prevail and international regulations are successful in controlling the high-seas catch. King crab harvests by U.S. fishermen should gradually increase as previously unexploited stocks are fished. Pacific halibut, sablefish, and Pacific ocean perch stocks and catches will probably continue at current low levels. Walleye pollock and Pacific cod catches will probably increase somewhat. Whale stocks will continue their precipitous decline, and their harvest will probably end within a few years as a consequence of conservation efforts and international treaties.

26938 (TID—26712, pp 493-510) **Sea mammals: resources and population.** Abegglen, C.E. (Fish and Wildlife Service, Anchorage, AK). Sep 1977.

In Environment of Amchitka Island, Alaska.

The marine mammal resources near Amchitka Island consist of sea otters, harbor seals, and Steller sea lions as permanent residents, northern fur seals that migrate through Aleutian passes, and whales and porpoises in the surrounding seas. Archaeological and historic data on animal populations indicate that the species present then were the same as those present today and demonstrate the continued importance that sea mammals have played in the island's history. Sea otter observations and surveys made from 1935 to 1974 document the recovery of this species from near extinction at the start of the twentieth century. Conservation measures, national and international, have been many, some even having been started in Russian times. The crucial and finally successful ones are the Fur Seal Treaty of 1911 and the Executive Order of 1913, which established what is now known as the Aleutian Islands National Wildlife Refuge. The marine mammal populations (whales excluded) around Amchitka and in the western Aleutian Islands are in good condition.

ENVIRONMENTAL-SOCIAL ASPECTS OF ENERGY TECHNOLOGIES

SOCIAL AND ECONOMIC STUDIES

REFER ALSO TO CITATION(S) 26419, 26496, 26512, 26898, 26899, 26922

26939 (BNWL—2395) **Calculation of population distribution using a computer data base.** Hill, E.R. (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). Aug 1977. Contract EY-76-C-06-1830. 10p. Dep. NTIS, PC A02/MF A01.

The program and data base were obtained from the U.S. Environmental Protection Agency (EPA), Office of Radiation Programs, and were developed primarily for marketing purposes by the U.S. Department of Commerce. The EPA subsequently adapted them for use in population exposure problems. The program at BNW is a modified version of the one developed by the EPA and is based on 1970 census data from the Department of Commerce. The program was used to study populations in the neighborhood of reactors. The output was aggregated for each reactor location and then introduced to other computer programs for additional calculations. In this study, the distributions were obtained for 10 concentric annuli within 80 km of the reactor sites. The annuli were divided into sixteen sectors centered on points of the compass. The population data base is an edited and compressed version of the 1970 U.S. Census Bureau's Master Enumeration District List with Coordinates. It consists of approximately 250,000 records, each of which represents a census enumeration district (CED). Each record contains the geographic coordinates of the population centroid for the district, population and housing counts, state and county codes.

26940 (PB—270899) **Technology facility siting characteristics and infrastructure needs. Final report.** (Battelle Columbus Labs., Ohio (USA)). Aug 1976. 702p. NTIS PC A99/MF A01.

This study developed data on coal, water, land, manpower and capital requirements of coal conversion facilities, and assessed the ability of the Appalachian region to support these facilities. Eight processes were considered, from coal cleaning to electric power generation and new technologies of coal gasification and liquefaction. Twenty-eight multi-county areas were identified as able to meet the requirements of these plants.

26941 **Comments on the consequences of the setting up of a nuclear power plant.** Masson, P. *Rev. Gen. Nucl.;* No. 3, 178-180(1977). (In French).

The consequences of the national decision of setting up a nuclear power plant are emphasized for the region whose site has been chosen. The regional impact affects the Administration (for information and controversy), economic activities, social life, and the local collectivities.

ASSESSMENT OF ENERGY TECHNOLOGIES

REFER ALSO TO CITATION(S) 26512

ENVIRONMENTAL IMPACT STATEMENTS

REFER ALSO TO CITATION(S) 26489

BIOMEDICAL SCIENCES, BASIC STUDIES

BEHAVIORAL BIOLOGY

REFER ALSO TO CITATION(S) 26903, 26904, 26928, 27001

26942 (TID—26712, pp 511-526) **Population estimates and feeding behavior of sea otters.** Estes, J.A. (Univ. of Arizona, Tucson). Sep 1977.

In Environment of Amchitka Island, Alaska.

Feeding behavior and the abundance of sea otters were studied at Amchitka Island, Alaska, between November 1970 and September 1972. Observations of feeding sea otters suggest no differences between sexes with regard to the amount of time spent diving or on the surface. Apparently, diving and surface times both increase in deeper water, but the percentages of time spent on the surface and submerged remain approximately constant throughout the day. No differences in either the pattern or the percentage of time spent feeding, resting, or grooming were observed between summer and winter. Shore-based counts of sea otters are consistently higher than aerial counts from helicopters. This probably is attributable primarily to the increased amount of time that can be spent viewing an area from shore-based stations and thus the detection of animals that otherwise would have been submerged and consequently not counted as the aircraft passed overhead. In 1972 the Amchitka Island sea otter population was estimated at about 6400 animals, approximately 40% of which were in the Bering Sea and 60% of which were in the Pacific Ocean. This distribution corresponds with the distribution of sea otter feeding habitat. Assuming that sea otters live within the 30-fathom (55-m) depth contour, I estimate an island-wide sea otter density of 59 animals per square nautical mile of habitat (17 per square kilometer). This estimate may be separated into 68 animals per square mile (20 per square kilometer) in the Bering Sea and 54 animals per square mile (16 per square kilometer) in the Pacific Ocean.

26943 (UCRL—13813) **Habitat requirements and population characteristics of the clapper rail (Rallus longirostris yumanesis) in the Imperial Valley of California.** Bennett, W.W.; Ohmart, R.D. (California Univ., Livermore (USA). Lawrence Livermore Lab.). Jan 1978. Contract W-7405-ENG-48. 55p. Dep. NTIS, PC A04/MF A01.

Habitat requirements and population characteristics of the Yuma Clapper Rail (Rallus longirostris yumanensis) were examined in the Imperial Valley of California during 1977. Rails used fresh water areas containing mature stands of cattail (Typha domingensis) and bulrush (Scirpus californicus). Water level variation was found to influence the permanence of territories and the breeding effort. Marsh areas with permanent shallow water through the breeding season contained highest rail densities. Hatching success was high (90 percent), but so was chick mortality, perhaps due to the chicks' inability to swim, the great variability of water levels, and possible predation. Clapper Rails began arriving in the Imperial Valley in mid-March and remained until the beginning of October. Time of appearance and disappearance of crayfish (Procambarus and Orcopectes, the most common genera) was closely correlated with the arrival and departure dates of Clapper Rails. Ninety percent of the territories of paired birds contained high numbers of crayfish. A complete census of the valley during the latter half of May, using tape-recorded calls, elicited responses from 160 individuals. A small overwintering population remained as determined by the sampling of high density areas in January and November. Rail management suggestions based on the results of this paper are also proposed.

BIOCHEMISTRY

REFER ALSO TO CITATION(S) 26953, 26959, 26987, 26995

26944 (CONF-780108—1) **Catalytic and structural properties of the pentafunctional/arom/enzyme conjugate.** Gaertner, F.H. (Oak Ridge National Lab., Tenn. (USA)). 1978. Contract W-7405-ENG-26. 9p. Dep. NTIS, PC A02/MF A01.

From Symposium on the role of compartmentation in metabolic regulation) micro-environmental aspects; Dallas, TX, USA (16 Jan 1978).

The arom enzyme conjugate exhibits several unique catalytic and structural features which may provide the system with various physiological advantages. The presence of all five activities on a single polypeptide chain may be important in both the coordinate activation and coordinate protection of the arom conjugate. The physical association of the enzymes may enable the system to respond rapidly with little or no transient to changes in metabolic flux, provide an inherent increase in the catalytic capacity of the individual enzymes and allow for the channeling of intermediate substrates, thereby sequestering them from a competing catabolic pathway.

26945 (COO—3162-36) **Annual progress report, September 1, 1976—November 30, 1977.** Clayton, R.K. (Cornell Univ., Ithaca, N.Y. (USA)). 1977. Contract EY-76-S-02-3162. 10p. Dep. NTIS, PC A02/MF A01.

We have extended our studies of the orientations of chromophores in photosynthetic membranes and reaction centers, using linear dichroism. Reaction centers could be oriented in stretched films of gelatin or polyvinyl alcohol, giving linear dichroic effects stronger than in dried films of membrane fragments, and different in the two types of film. These different preparations allow us to construct three-dimensional models of the orientations of bacteriochlorophyll and other chromophores in reaction centers and in relation to the membrane. Such modeling is under way for two distinctive types of photosynthetic bacteria: Rhodopseudomonas sphaeroides and R. viridis. We have improved our ability to resolve optically those components of bacteriochlorophyll and bacteriopheophytin that engage in photochemical electron transfer and those that do not. We have begun to elucidate the cycle of one-electron and two-electron redox states of quinones engaged in photosynthetic electron transfer, by measuring optical absorbance changes that signal these reactions. Light flashes, each promoting one turnover (photochemical electron transfer) in every reaction center, were applied to isolated reaction centers and to membrane fragments. Consecutive flashes caused alternately the reduction of quinone to semiquinone and the reduction of semiquinone to the fully reduced form. Protons are bound only by the fully reduced form. The conversion of semiquinone to fully reduced quinone happens in secondary quinones and not in the primary quinone of the reaction center.

26946 (COO—3277-44) **Chemical production of excited states: adventitious biological chemiluminescence of carcinogenic polycyclic aromatic hydrocarbons.** Seliger, H.H.; Hamman, J.P. (Johns Hopkins Univ., Baltimore, Md. (USA). McCollum-Pratt Inst.). 1977. Contract EY-76-S-02-3277. 15p. (CONF-770346—3). Dep. NTIS, PC A02/MF A01.

From Symposium on excited states in organic and biochemistry; Jerusalem, Israel (28 Mar 1977).

In view of all the circumstantial evidence that the expression of carcinogenicity requires metabolism of the parent carcinogen, metabolism that takes place predominantly at some distance from the K region, it becomes difficult to understand why there should exist some partial correlation between the electron density or reactivity of the K region of a parent PAH and the carcinogenicity of one of its subsequent metabolites. In this paper we shall show that the electronic theories of carcinogenesis describe different parameters of the parent carcinogenic hydrocarbon that are involved in its metabolic conversion to a reactive bay region epoxide, the presumed ultimate carcinogenic metabolite. We describe nonspecific and specific chemical production of excited states in biological systems and propose that specific ABC is a measure of the chemical reactivity and rate of production of epoxide metabolites during drug metabolism of carcinogenic polycyclic aromatic hydrocarbons.

26947 (COO/4502—1) **Bio-oxidation of aqueous cyanogens typical of Synthane gasifier by-product water. Progress report, September 1, 1977—November 30, 1977.** Neufeld, R.D.; Valiknac, T. (Pittsburgh Univ., Pa. (USA). Dept. of Civil Engineering). Nov 1977. Contract EY-77-S-02-4502. 10p. Dep. NTIS, PC A02/MF A01.

Acclimated biological cultures were developed from activated sludge taken from coke plant biological waste treatment facilities. These cultures are capable of degrading potassium thiocyanate from an original concentration of 500 mg/l SCN to less than 1 mg/l in an aeration period of 24 hours pH inhibition appears to be significant at values greater than 7.6. Preliminary assessments indicate that aerobic biological organisms may play a major role in the removal of aqueous thiocyanate as found in the wastewaters from the gasification of certain coals.

26948 (ORO—3630-26) **Photorepair of uv damage to DNA: purification and properties of DNA photolyase (the DNA-photoreactivating enzyme). Progress and final reports, August 1, 1976—July 31, 1977.** Werbin, H. (Texas Univ., Austin (USA)). 1977. Contract EY-76-S-05-3630. 58p. Dep. NTIS, PC A04/MF A01.

Studies on modification of amino acid residues in photolyase with diketene are discussed. Materials and methods are described for N-bromosuccinimide (NBS) from arapaho chemicals, hydrogen peroxide from Topeo, and diketene from ICN Pharmaceuticals. Results are discussed with regard to attempts to modify tryptophan residues in photolyase and attempts to modify E-amino group of lysine in photolyase with diketene. (HLW)

26949 (RLO/2225/T19—43) **Studies on the control of cell wall extension. Progress report, July 1, 1976—September 1, 1977.** Cleland, R.E. (Washington Univ., Seattle (USA)). 11 Aug 1977. Contract EY-76-S-06-2225-019. 18p. Dep. NTIS, PC A02/MF A01.

Progress is reported on the following research projects: the role of respiratory CO_2 in hormone-induced acidification; effect of fusicoccin on PEP carboxylase; protein synthesis and auxin-induced H^+-excretion; calcium and wall extensibility; acid-induced elongation of Valonia walls as compared with coleoptiles; and role of wall loosening capacity and osmoregulation in controlling cell elongation. (HLW)

26950 **Yeast mitochondrial DNA specifies tRNA for 19 amino acids. Deletion mapping of the tRNA genes.** Martin, N.C.; Rabinowtiz, M.; Fukuhara, H. (Univ. of Chicago). *Biochemistry;* **16**: No. 21, 4672-4677(18 Oct 1977).

We have previously identified 14 aminoacyl-tRNAs that are specified by yeast mitochondrial DNA (mtDNA). We now report four more amino acids (Arg, Cys, Trp, Thr) that acylate tRNAs which hybridize with mtDNA. Furthermore one of the two mitochondrial tRNAs that we had earlier demonstrated to be directly charged with glutamic acid responds to glutamine but not to glutamic acid codons. Thus Gln-tRNA/sup Gln/ appears to be formed by transamidation of a missense intermediate Glu-tRNA/sup Gln/. This brings to 19 the number of amino acids which have corresponding tRNAs specified by mtDNA. Only tRNA/sup Asn/ has not yet been shown to be a mtDNA transcript. We have also mapped the genes for the newly identified mitochondrial tRNAs, as well as several others that were previously identified but unmapped, by hybridization to the mtDNA of a series of petite deletion mutants. We now have ordered 20 mitochondrial tRNA genes (including two methionyl-tRNAs) with respect to the antibiotic resistance markers chloramphenicol (C/sup R/), erythromycin (E/sup R/), paromomycin (P/sup R/), and oligomycin I and II (O/sup R//sub I/, O/sup R//sub II/). Eighteen tRNA genes map between the C and E resistance markers. Only the serinyl-tRNA and glutamyl-tRNA genes are localized near the O/sub I/ and O/sub II/ resistance markers.

26951 (LA-tr—77-66) **Electronic properties of n-heteroaromatics, LVII. Intermolecular interaction of the anti-tumor dye nile blue A and deoxyribonucleic acid (DNA).** Okano, T.; Horie, T.; Motohashi, N. Translated from *Yakugaku Zasshi;* **96**: No. 7, 891-898(1976). 19p. Dep. NTIS, PC A02/MF A01.

Studies were made on the intermolecular interaction of the oxazino dye Nile Blue A and calf-thymus deoxyribonucleic acid (DNA). It was concluded from these experimental results that two modes of interaction, ionic binding of the basic dye and the phosphate group of DNA, which leads to metachromasis of the dye, and intercalation of the dye between adjacent base-pairs of the macromolecule, are taking part in the binding of Nile Blue A and DNA. When this dye was mixed with DNA at pH 7.0, intensity of its characteristic absorption bands (α and β bands) decreased, and new absorption bands appeared in the vicinity of 550 nm (γ band) and 668 nm (delta band). The γ-band was produced when the molar ratio of [Dye]/[DNA-P] was greater than 1, while the delta-band was produced when this molar ratio was smaller than 1. Flow dichroism spectrum of the delta-band indicated that the Nile Blue A molecule was oriented perpendicularly to the longer axis of the double helix of DNA; dichroism was not observed with a mixture of this dye and heat-denatured DNA. The γ absorption band was also produced by the mixed system of Nile Blue A and potassium poly(vinylsulfonate); no spectral change was observed with a monomeric vinyl sulfonate. Mixed systems of Nile Blue A and a high concentration of purine nucleosides or mononucleotides exhibited a larger delta band than the systems in which corresponding pyrimidine derivatives were involved. Larger spectral changes were produced by the interaction systems of Nile Blue A and purine homopolynucleotides than by the systems in which pyrimidine homopolynucleotides were involved. Viscosity and melting temperature of DNA increased with increasing concentration of this dye added.

CYTOLOGY

REFER ALSO TO CITATION(S) 26980, 26981

26952 (CONF-770504—) **Proceedings of the 14th annual electron microscopy colloquium.** Laabs, F.C. (ed.). (Ames Lab., Iowa (USA); National Animal Disease Center, Ames, Iowa (USA)). Oct 1977. Contract W-7405-ENG-82. 181p. Dep. NTIS, PC A09/MF A01.

From 14. annual proceedings on electron microscopy; Ames, IA, USA (12 May 1977).

Separate abstracts were prepared for the 16 papers presented at the conference. (HLW)

26953 (CONF-770504—, pp 24-35) **Membrane biogenesis: an application of biochemistry and cytochemistry to electron microscopy.** Barrnett, R.J.; Higgins, J.A. (Yale Univ. School of Medicine, New Haven). Oct 1977.

From 14. annual proceedings on electron microscopy; Ames, IA, USA (12 May 1977).

In Proceedings of the 14th annual electron microscopy colloquium.

This report presents membrane biogenesis in which the synthesis and assembly of components, phospholipid and enzyme proteins, were studied by combining the methods of biochemistry, cytochemistry and electron microscopy. One study presented in the following review concerns the proliferation of smooth ER in rat hepatocytes administered phenobarbital in which evidence will be presented that the smooth ER synthesized its own phospholipids and therefore assembly occurs in situ. The other example presented only from platform, concerns the secretory cells of the duckling salt gland in which there is a remarkable amplification of the plasma membrane at the lateral and basal surfaces in response to salt stress. Evidence will be presented to show that some elements of the Golgi apparatus are concerned with phospholipid synthesis. Golgi elements are also concerned with assembly of phospholipid and enzymatic protein and the delivery of new plasma membrane to the surface by vesicles.

26954 (CONF-770504—, pp 60-71) **Enzyme localizations in hepatocytes following triton WR-1339 injection.** Trout, J.J.; Viles, J.M. Oct 1977.

From 14. annual proceedings on electron microscopy; Ames, IA, USA (12 May 1977).

In Proceedings of the 14th annual electron microscopy colloquium.

Electron microscopic morphological and cytochemical techniques were used to follow the sub-cellular events that accompany Triton WR-1339 uptake in rat hepatocytes. Localization of two lysosomal enzymes, acid phosphatase and aryl sulfatase, clearly establishes the lysosomal nature of the Triton WR-1339 containing electron-lucid structures that appear in hepatocytes following treatment with this compound.

26955 (CONF-770504—, pp 88-94) **Decidual cell secretion, a unique mode of exocytosis.** Herr, J.C.; Heidger, P.M. Jr. (Univ. of Iowa, Iowa City). Oct 1977.

From 14. annual proceedings on electron microscopy; Ames, IA, USA (12 May 1977).

In Proceedings of the 14th annual electron microscopy colloquium.

Electron microscopic studies of decidual cells obtained from the human ovary at term reveal fine structural features of active secretion. The plasmalemma evaginates into peduncular process, within which are electron dense, membrane bounded secretion bodies, 0.4 to 0.9 μm in diameter. These secretion bodies contain granular subunits, 30 to 50 nm in diameter. First observed in the region of the Golgi apparatus, these secretion bodies apparently move into peduncular processes where they are stored prior to degranulation of their subunits. Exocytosis of a population of peripheral particles stored in peduncular processes appears to be a mode of merocrine secretion unique to decidual cells.

26956 (CONF-770504—, pp 129-134) **Gross distortions in freeze-dried tissue preparations.** Ingram, F.D.; Ingram, M.J. (Univ. of Iowa, Iowa City). Oct 1977.

From 14. annual proceedings on electron microscopy; Ames, IA, USA (12 May 1977).

In Proceedings of the 14th annual electron microscopy colloquium.

With the electron microprobe, we have examined a variety of tissue types that have been freeze-dried. These measurements indicate that the volume changes are uniformly distributed throughout the tissue and no further intracellular distortions are apparent at the 1μm resolution level. An example of typical electron probe measurements of intracellular K, Cl and Na concentrations in frog skeletal muscle is presented. The tissue had been freeze-dried, fixed with OsO_4 vapor, embedded in Epon 826, and the sample block faced with a steel knife microtome. The uniformity of the data suggests that the shrinkage associated with the preparation is evenly distributed throughout the sample. From the reasonable values of the measurements, it appears that the tissue shrinkage was not materially different from shrinkage of the albumin standards against which Na X-ray intensities were compared.

26957 (CONF-770504—, pp 172-175) **Three-hour rapid processing technique for electron microscopy.** Oct 1977.

From 14. annual proceedings on electron microscopy; Ames, IA, USA (12 May 1977).

In Proceedings of the 14th annual electron microscopy colloquium.

Specimens can be prepared for electron microscopy in three hours instead of the usual 36. Rapid processing is made possible by three changes in conventional technique: tissue pieces are cut smaller, curing temperatures are increased and 2,2-dimethoxypropane (DMP) replaces the usual alcohol or acetone dehydration series. The technique can be modified to accommodate uranyl acetate en bloc staining or alcohol dehydration for tissues which might be adversely affected by DMP's solvent properties. The technique gives excellent results and, although it was originally intended for processing diagnostic specimens only, we are not using it for all routine specimens.

26958 (CONF-770504—, pp 176) **Procedural tip for intestine sections.** Buck, D.I. Oct 1977.

From 14. annual proceedings on electron microscopy; Ames, IA, USA (12 May 1977).

In Proceedings of the 14th annual electron microscopy colloquium.

The problem encountered was that bacteria on the luminal surface of intestinal mucosae were demonstrable on fluorescent-antibody stained cryostat sections. However, when adjacent tissue was processed for transmission electron microscopy, very few bacteria were retained. Assuming that bacteria were lost by mechanical rinsing during processing, our objective was to provide a supporting matrix to retain surface feature integrity through processing.

26959 (COO—2223-25) **Spin label studies on membranes and the aqueous zones of membrane enclosures. Progress report, period covered: August 1976 to the present.** Keith, A.D. (ASEA, Inc., White Plains, N.Y. (USA)). Aug 1977. Contract EY-76-S-02-2223. 23p. Dep. NTIS, PC A02/MF A01.

The feasibility of measuring properties of the aqueous cytoplasm with spin labels is established. The parameters of protected aqueous cell volume, restriction of rotational motion of probe molecules, and limitations placed on translational diffusion of probe molecules by the aqueous cytoplasm are described. A class of spin labels called surface spin labels, designed to probe charge and other surface properties of membranes is described. These spin labels have undergone initial characterization, and in yeast cells it has been confirmed that essentially all of the spin label signal can be isolated to the cell surface.

26960 (COO—3110-28) **Cellular heredity in haploid cultures of somatic cells. Annual progress report, April 1976—July 1977.** Freed, J.J. (Institute for Cancer Research, Philadelphia, Pa. (USA)). Aug 1977. Contract EY-76-S-02-3110. 13p. Dep. NTIS, PC A02/MF A01.

This report briefly summarizes our research of the past year on the origin of drug resistant variants from haploid cell cultures, in particular on the effects of mutagens and modes of DNA repair on the frequency of induced variants. Other studies have continued our analysis of the mechanisms of resistance to bromodeoxyuridine and to microtubule agents in variants isolated in prior work. New observations on the chromosomes of the haploid cells are also presented.

26961 (LA—7076-PR) **Automated cancer-cell sorting and analysis. Progress report, June 1—November 30, 1977.** Mullaney, P.F.; Steinkamp, J.A.; Salzman, G.C.; Zvitra, Z.V.; Crowell, J.M.; Martin, J.C.; Hansen, K.M.; Skogen-Hagenson, M.J.; Hiebert, R.D.; Genter, F.C. (Los Alamos Scientific Lab., N.Mex. (USA)). Jan 1978. Contract W-7405-ENG-36. 37p. Dep. NTIS, PC A03/MF A01.

Progress is reported on the development of a two-laser system, experimentation and characterization of new stains for use with the krypton laser, and light-scattering studies for the identification of cancer cells during automated cell sorting. Significant progress was also made with a color graphics method of visualizing and analyzing complex light-scattering patterns.

26962 (LA—7120-MS) **Clustering algorithm for mixtures of monotone densities.** Goad, C.A. (Los Alamos Scientific Lab., N.Mex. (USA)). Jan 1978. Contract W-7405-ENG-36. 7p. Dep. NTIS, PC A02/MF A01.

A clustering algorithm is presented which proceeds by systematically exploring the hill or mode structure of a set of sample points. The algorithm is designed for clustering problems where it is believed that the component density functions responsible for producing the sample points are monotone (i.e., have one peak or high plateau from which they monotonically decline). Examples of algorithm performance given include cell classification in cell flow systems.

26963 **Splenic remodeling of red cell surfaces.** Crosby, W.H. (Scripps Clinic and Research Foundation, La Jolla, CA). *Blood;* **50**: No. 4, 643-645(Oct 1977).

The processes whereby the spleen remodels red cell surfaces all involve a mechanical disposal of defective red cells or portions of red cells. Some portion of red cell remodeling might occur through metabolic attrition. Is the protein aggregate of Lux and John present as beads attached to the inner layer of the red cell membrane, or is it a functional membrane constituent of erythroblasts and reticulocytes. If it is in beads, then mechanical removal is feasible. Smoothly distributed (essential, perhaps, for the ameboid movement of young red cells), it could not be pinched off as an inclusion body. If this were the case, the metabolic removal or disaggregation of the aggregate must somehow require the mysterious ambience of the microcirculation of the spleen. Whatever the splenic mechanism for its removal, the newly discovered phenomenon is that the high molecular weight protein complex of Lux and John remains in the red cell population postsplenectomy. This finding does not necessarily mean, as they suggest, that it is not harmful. Its existence may result in splenic destruction of any cell that possesses it. If, however, it is present in only a few of the circulating cells, their premature demise would not result in discernible hemolytic disease. It remains to be learned if the spleen destroys entire red cells to remove the protein aggregate or if it removes only offending portions, permitting the remodeled red cells to survive.

26964 (LA-tr—78-3) **Mathematical model of the connection between the DNA karyogram and the cell cycle. Part 1. Derivation of the DNA frequency distribution from the duration of the individual phases of the cell cycle.** Krug, H. Translated from *Acta Histochem.;* **56**: 140-155(1976). 26p. Dep. NTIS, PC A03/MF A01.

Encouraged by our own experiments on flow-through fluorescence photometry (impulse cytophotometry) a mathematical model was developed which expresses the connection between the duration of the individual phases of the cell cycle and the curve of DNA frequency distribution (DNA Karyogram) in the form of operational equations. Certain presuppositions and restrictions must be assumed in order to derive the equations. The DNA karyogram (frequency of cell nuclei in a uniform population as a function of DNA content) was construed as a graph with 3 superimposed curves. These curves represented the following: a Gaussian distribution of G_1 phase cells at the first or 2c peak around the diploid DNA content; a Gaussian distribution of G_2 + M phase cells at the second or 4c peak (twice the DNA content of the diploid value); and cell nuclei from the S phase with DNA values between the mean values of the standard distributions of the two peaks.

26965 (LA-tr—78-2) **Impulse cytophotometric investigations on melanoblastoma.** Krug, H.; Schonfelder, M. Translated from *Arch. Geschwulstforsch.;* **45**: No. 4, 347-367(1975). 29p. NTIS, MF A01.

We investigated 24 patients with melanotic tumors (under them 22 malignant melanoms). The tumor material (31 x by biopsy, 2 x by autopsy) was homogenized and stained with Ethidium bromide after pepsination. The distribution of the DNA content of the tumor cell nuclei was measured by impulse cytophotometry. The criterion for the curves was the height of the 4-c-peak in percentage of the diploid peak. The course of the disease (as seen by metastasis, effect of chemotherapy, growing in cell culture) runs parallel to the findings of impulse cytophotometry. In one case of melanosis praeblastomatosa circumscripta Dubreuilh we found a pure diploid cell population without peaks at 4-c. For prognosis (not for diagnosis) the impulse cytophotometric investigation of malignant melanoma is more suitable than the histology. The connections between proliferation and DNS distribution of cell nuclei in a tetraploid population are discussed. The terminology of cell cycle phases is extended to tetraploid populations with new terms (G', S'). In some cases we found stem lines. As shown by repeated impulse cytophotometric investigations a changing of stem lines in the DNA distribution curve is possible (change from hyperdiploid to tetraploid). The impulse cytophotometry is suitable for such investigations on melanomas.

26966 (LA-tr—78-4) **Applications of interference microscopy for measurements on the cell nucleus in comparison with impulse cytophotometry.** Taubert, G.; Krug, H. Translated from *Acta Histochem., Supplementb.;* **15**: 397-415(1975). 30p. Dep. NTIS, PC A03/MF A01.

The advantage of the method using interference optics consists in the fact that it involves a process which is completely independent of histochemical stain reactions. This measuring method may be regarded as one of the most accurate optical measuring methods in existence. It permits the direct illustration of path differences as brightness differences (for monochromatic light) or color differences (for polychromatic light). Another point to be emphasized is the possibility of observing and measuring living cells without causing any damage to the test object. A certain drawback is the unspecificity of the measurement which can be limited by certain preliminary treatments, for example with enzymes. The speed with which one can work with interference microscopy is limited, since the path difference and surface area must be determined in several steps. This speed lies in about the same order of magnitude as that for working with plug cytophotometry. Thus, in measurements on the cell nucleus, the number of nuclei which can be measured is smaller by a power of 10 than when using highly automated impulse cytometry which allows 10^4 to 10^6 nuclei to be measured in a short time. With interference microscopy it is possible to determine the dry mass, concentration, mass per unit area or thickness in absolute units. Impulse cytophotometry, on the other hand for all practical purposes, permits only relative measurements, but this drawback is of no consequence in karyophotometry, since in this case diploid calibration material is always available.

GENETICS

REFER ALSO TO CITATION(S) 26950, 26960, 26987

26967 (BNL—23558) **Genus nicotiana as a genetic resource. Chapter 1.** Smith, H.H. (Brookhaven National Lab., Upton, N.Y. (USA)). 1977. Contract EY-76-C-02-0016. 50p. NTIS, MF A01.

Portions of document are illegible.

The following topics are discussed: taxonomy of nicotiana; polyploidy, aneuploidy, and the origin of nicotiana tabacum; biometrical studies; biochemical genetics with emphasis on alkaloids and isozymes; evidence for genetic control of tumors; physiological characteristics of genetic tumors; and unique advantages of nicotiana for future genetic research. (HLW)

26968 (SRO—735-5) **Studies on mechanisms of mutation, recombination, and gene action in neurospora. Final report.** Giles, N.H. (Georgia Univ., Athens (USA). Dept. of Zoology). 1 Oct 1977. Contract EY-76-S-09-0735. 6p. Dep. NTIS, PC A02/MF A01.

During the past four year period the central emphasis in the studies supported by this contract has been on the organization, function and evolution of gene clusters in eucaryotes. Two very different gene clusters have been investigated in detail - the arom cluster and the qa cluster. It is felt that these two clusters are probably representative of gene clusters in other eucaryotes generally, including more highly evolved species. Thus present genetic and biochemical evidence suggests that two basic types of gene clusters occur in eucaryotes. The first type encodes an enzyme aggregate (multienzyme complex). In an increasing number of instances, such gene clusters have been shown to be "cluster-genes", i.e., single genes encoding multifunctional polypeptide chains, typically associated as homopolymeric aggregates. In several instances, evidence supports a channeling role for such enzyme aggregates, i.e., the aggregate serves to sequester intermediates in a particular biochemical pathway and prevent competition between two potential competitive pathways. Gene clusters are considered to have evolved by "retroevolution" involving successive tandem gene duplication followed by functional divergence. Apparently, natural selection has often resulted in the further evolution of such gene clusters into cluster-genes by the process of gene fusion, especially in eucaryotes. The second (and apparently less frequent) type of gene cluster in eucaryotes is a true cluster of contiguous but separate genes which do not encode an enzyme aggregate. Certain of these clusters appear to have operonlike characteristics. However, in the absence of evidence for polycistronic mRNA production, at least one of these clusters (the qa cluster in Neurospora) appears to be maintained by natural selection because it contains a gene encoding a regulatory protein which is primarily cis-acting.

METABOLISM

REFER ALSO TO CITATION(S) 26946

26969 (COO—3231-5) **Effect of light on respiration and development of photosynthetic cells. Progress report, June 1, 1976—August 31, 1977.** Gibbs, M. (Brandeis Univ., Waltham, Mass. (USA)). 31 Aug 1977. Contract EY-76-S-02-3231. 18p. Dep. NTIS, PC A02/MF A01.

Hydrogen metabolism studies included chloroplast stability using the reconstituted preparation of the algae, chlamydomonas and Englena, spinach and peas; oxygen inactivation and carbon monoxide inhibition of hydrogenase from chlamydomonas; and H_2 photoevolution in intact cells. Studies on photorespiration included mechanisms of glycolate biosynthesis and relationships between plant morphology and photosynthesis. (HLW)

26970 (TID—26712, pp 569-577) **Sea otter metabolism and heat economy.** Morrison, P.R. (Univ. of Alaska, Fairbanks); Rosenmann, M.; Estes, J.A. Sep 1977.

In Environment of Amchitka Island, Alaska.

In ten 13- to 33-kg sea otters captured and maintained at Amchitka Island, a basal metabolic level of 0.72 $cm^3\ O_2\ g^{-1}\ hr^{-1}$ was found in 17 values measured over thermoneutral zones of -20 to 21°C in air and 20 to 33°C in water. Average values of 1.0 and 1.2 $cm^3\ O_2\ g^{-1}\ hr^{-1}$ and maximum values of 1.9 and 2.6 $cm^3\ O_2\ g^{-1}\ hr^{-1}$ in air and water, respectively, confirm the high food demand of one-fifth to one-fourth their body weight in fish daily. Minimum thermal conductance in air, less than 0.012 $cm^3\ O_2\ g^{-1}\ hr^{-1}\ °C^{-1}$, was greater for these mammals than for terrestrial arctic mammals, but it only increased twofold on immersion in water. Water infiltration into the fur above 25°C allowed survival at even 33°C. Body temperature was regulated under neutral conditions at 38.1 +- 0.34°C (mean +- standard deviation), under cold conditions at 36.7 +- 0.45°C, and under warm conditions at 38.5 +- 0.31°C with 44.1°C as a single lethal value.

MEDICINE

REFER ALSO TO CITATION(S) 26028

TRACER TECHNIQUES

26971 (COO/4268—1) **Biomedical research and application utilizing cyclotron produced radionuclides. Progress report, January 1 1977—December 31, 1977.** Laughlin, J.S.; Benua, R.S.; Tilbury, R.S. (Sloan-Kettering Inst. for Cancer Research, New York (USA)). 30 Sep 1977. Contract EE-77-S-02-4268. 91p. Dep. NTIS, PC A05/MF A01.

Portions of document are illegible.

Progress is reported on cyclotron production of short-lived positron-emitting radionuclides (^{18}F, ^{15}O, ^{11}C, ^{13}N, ^{52}Fe, ^{38}K, ^{206}Bi, ^{73}Se, and ^{48}Cr) for use in the preparation labelled compounds for metabolic research in patients and animals. The chemical preparation of radiopharmaceuticals labelled with cyclotron-produced radionuclides for pancreas and tumor scanning is discussed. The imaging capabilities of a total organ kinetic imaging monitor (TOKIM) gamma camera system operated in the positron coincidence mode were improved with the addition of computerized iterative correction procedures.

26972 **Bone-seeking radionuclides: an in vivo study of factors affecting skeletal uptake.** Genant, H.K.; Bautovich, G.J.; Singh, M.; Lathrop, K.A.; Harper, P.V. (Univ. of Chicago). *Radiology;* **113**: No. 2, 373-382(Nov 1974).

The factors governing the skeletal uptake of bone-seeking radionuclides in vivo have not been clearly defined. In this study, the effects of alteration in blood flow (thermal-induced) and alteration in

osteogenesis (ricket-induced) on the skeletal uptake of these agents in rats were investigated. In vivo quantitative data were corroborated by the use of autoradiographic and well-counting techniques. Results indicate that the short-term uptake of commonly used bone-scanning agents is closely correlated with blood flow and is largely independent of the rate of osteogenesis.

26973 **Tumor scanning agents.** Hoffer, P.B.; Gottschalk, A. (Univ. of Chicago). *Semin. Nucl. Med.;* **4**: No. 3, 305-315(Jul 1974).

Nuclear imaging studies currently play a major role in the detection, staging, and management of malignant disease. However, most imaging methods with agents currently in use localize malignant disease indirectly by revealing changes in normal anatomy or physiology. These methods are inherently nonspecific. The development of direct tumor scanning agents, which localize in the tumor itself, holds considerable promise. Substances currently in use include radiolabeled metabolites, radioactive cations, and radiolabeled antimetabolites. At least some of these agents show good specificity. Radiolabeled antibodies to tumor-associated antigens are currently undergoing initial investigation as direct scanning agents with high tumor specificity.

MICROBIOLOGY

REFER ALSO TO CITATION(S) 26952

26974 (CONF-770504—, pp 1-13) **Ultrastructural studies on Friend leukemia virus.** Evenson, D.P.; de Harven, E. (Sloan-Kettering Inst. for Cancer Research, New York). Oct 1977.

From 14. annual proceedings on electron microscopy; Ames, IA, USA (12 May 1977).

In Proceedings of the 14th annual electron microscopy colloquium.

Friend leukemia virus derived from leukemic cells in culture have significantly less leukemogenic activity than virus derived from the plasma of Friend leukemia virus infected mice. These comparative data were quantitatively based on the actual number of viruses used in each experiment as determined by counting under the electron microscope. The fine structure of these two virus variants is very similar and samples of both viruses contain the same ratio of C-type to "enveloped A-type" particles. The sizes of noncovalently linked RNA subunits isolated from the tissue culture derived virus (TCV) were about half that of the RNA subunits isolated from the plasma derived virus (PV) as determined by the Kleinschmidt technique. The smaller sizes of the TCV RNA subunits are hypothetically related, at least in part, to the limited biological activity of Friend leukemia virus produced in culture.

26975 (CONF-770504—, pp 14-15) **Ultrastructure of cryptosporidia in the Bovine species.** Pohlenz, J. (Kantonales Tierspital, Zurich); Moon, H.W.; Bemrick, B. Oct 1977.

From 14. annual proceedings on electron microscopy; Ames, IA, USA (12 May 1977).

In Proceedings of the 14th annual electron microscopy colloquium.

Cryptosporidia are protozoa of the suborder Eimeroninae representing the genus Cryptosporidium. They are described in several species of animals and in man. In general, they develop in the brush border of the epithelial cells of the intestine. Though they are detectable in histologic sections, it is necessary to determine the stage of their life cycle by electron-microscopy. Their complete life cycle is not yet known. There are, however, free intraluminal stages, trophozoites, schizonts and gametes detectable. Cystic organisms which are supposed to be oocysts are occurring in both the intestine and in pelleted fecals. From these investigations there was no cell invasion demonstrable as concluded by others in Cryptosporidium wrairi in the guinea pig. It is thought that these protozoa may play a role in the syndrome of neonatal calf diarrhea.

26976 (UR—3490/LCP-2) **Effects of high temperature on infections of E. coli B by bacteriophage T4D and its mutant in gene regA.** Mowrey, M.F. (Rochester Univ., N.Y. (USA). Dept. of Radiation Biology and Biophysics). 1977. Contract EY-76-C-02-3490. 148p. Dep. NTIS, PC A07/MF A01.

Thesis.

The existence of post-transcriptional regulation in T4-infected E. coli is becoming apparent. Although no known T4 gene has been shown definitively to be involved in post-transcriptional regulation, circumstantial evidence argues that regA is such a gene. SP62, a mutant of the regA gene, has been described by Wiberg et al. (1973) and is now referred to as regAl. In the absence of DNA synthesis (DNA^- state) a regAl infection (regAl, DNA^-) at 37°C shows drastic overproduction of many early enzymes for at least 60 minutes post-infection, whereas in the DNA^- infection alone, synthesis of these enzymes shuts off at 20 minutes. In a $T4^+$ infection at 37°C synthesis of these same early enzymes shuts off at 12 minutes post-infection; a small overproduction of early proteins (due to extended synthesis) is seen late in infection with the regAl mutant alone. RegAl shows a greater decrease in phage production relative to wild-type at temperatures above 40°C (despite no effect on rate of DNA synthesis) whereas at 37°C phage production is near normal. Production of both phage is more temperature-sensitive in M9 (minimal) medium than in glycerol-casamino acids (GCA). At 44.8°C using E. coli B in GCA, wild-type produces 4.3 times as many infective phage particles as regAl does and packages 2.5 times as much DNA as regAl; of the total regAl DNA packaged, only 1/5 is infective, whereas 1/2 of wild-type, packaged DNA is infective. These data suggest the following for T4D infections at high temperature: difficulty in packaging of the DNA and difficulty in converting DNA-filled heads to completed phage particles, with regAl exhibiting more of a defect than wild-type for both phenomena. Thermal lability of infective phage particles, both intracellular and extracellular, does not seem to be a factor in decreased accumulation of infective phage particles in regAl-infected cells at high temperature in GCA or M9 media.

26977 (UR—3490/LCP-4) **Characterization of an enveloped mycoplasmavirus.** Putzrath, R.M. (Rochester Univ., N.Y. (USA). Dept. of Radiation Biology and Biophysics). 1977. Contract EY-76-C-02-3490. 147p. Dep. NTIS, PC A07/MF A01.

Thesis.

The growth of an enveloped mycoplasmavirus MVL2 was studied, using the indicator hosts Acholeplasma laidlawii strains JA1 and M1305/68. Viral growth was characterized by one step growth and adsorption experiments. From artificial lysis experiments and infected cell growth curves, it was found that viral infection is nonlytic. Electron micrographs of infected cells showed that MVL2 matures by budding from the host cell membrane. Since other reported lipid-containing viruses of prokaryotes are lytic, MVL2 represents a previously undescribed class of viruses. A. laidlawii cells infected with MVL2 continue to grow and produce virus; therefore, a persistently infected cell culture could be established. Persistently infected cultures were cloned in the absence of free virus. All clones so obtained were found to be resistant to homologous virus but not to heterologous mycoplasmavirus. Clones of three phenotypes were isolated from the persistently infected culture: clones containing high titers of virus, clones containing low titers of virus, and clones containing no virus. The low virus containing phenotype was examined further. Cloning such a culture showed that virus resistant cells which are no longer producing virus can be the progeny of an infected cell and the low virus phenotype is a property of each virus-producing cell in the culture. Low virus containing cultures could be induced to produce more virus by treatment with mitomycin C and irradiation with ultraviolet light.

MORPHOLOGY

REFER ALSO TO CITATION(S) 26952, 26983

26978 (CONF-770504—, pp 36-42) **Structural variations of the endoplasmic reticulum of the jejunal mucosal cell.** Jasper, D.K. (Illinois Inst. of Tech., Chicago). Oct 1977.

From 14. annual proceedings on electron microscopy; Ames, IA, USA (12 May 1977).

In Proceedings of the 14th annual electron microscopy colloquium.

The endoplasmic reticulum (ER) of the intestinal epithelial cell is quite varied as to its relative abundance and type. Some of the variations are associated with the extent of cellular development or differentiation and some, apparently, to the type of substrate being metabolized. When isolated jejunal slices were incubated in the presence of a mixture of amino acids, ribosome-bearing ER elements became dilated and appeared to show a quantitative increase. At the same time relative numbers of free ribosomes decreased. The rough-surfaced ER elements of unincubated rings and slice samples frequently appeared as cisternae organized in stacks of 3 to 4 parallel units. In the rings these cisternae were identified primarily as being in cells occupying upper villous regions. In some mucosal cells occupying the lower villous regions, the ER cisternae associated with annulate lamellae as a complex. In some cases, as suggested by the characteristics of the complex, annulate lamellae may be involved in the formation or elaboration of the ER of jejunal mucosal cells. Other aspects in the variation of ER elements include the appearance of vesicular units of varying sizes; many of these units were ribosome free and contained lipid droplets. In conclusion, it may be stated that morphological variations of the endoplasmic reticulum of the mucosal cell of the rat jejunum may be linked to the degree of cellular differentiation as well as to the metabolism of particular substrates.

26979 (CONF-770504—, pp 95-128) **Ultrastructure of the life cycle of rust fungi.** Littlefield, L.J. (North Dakota State Univ., Fargo). Oct 1977.

From 14. annual proceedings on electron microscopy; Ames, IA, USA (12 May 1977).

In Proceedings of the 14th annual electron microscopy colloquium.

The haploid pycnial and the dikaryotic aecial stages are characterized by extensive intercellular mycelium with intracellular branches into host cells. These branches are elongated and septate, not typical haustoria observed in later stages of the life cycle. Pycniospores form as enteroblastic phialospores in pycnia and are haploid and smooth surfaced. Aeciospores are dikaryotic and form as meristem arthrospores with cog-like ornaments. The latter are formed by the combination of an extrusive process and disintegration of wall material between the cogs. Dikaryotic uredial and telial stage intercellular hypahe bear typical, lobate, nonspetate haustoria which extend into the host cells without penetrating the host's plasma membrane. Urediospores develop as enteroblastic sympodulospores from generative cells at the base of the uredium. Urediospore walls are multilayered and bear spines which originate on the inner surface of the immature wall, increase in size, pass through the wall, and eventually reside on the spore surface. The entire spore is surrounded by a thin, wrinkled outer layer. Teliospores form in a variety of developmental ways. Their cell walls are thick and variously sculptured, formed typically by localized deposition and/or dissolution of wall materials. Basidiospores produced upon germination of teliospores have not been studied ultrastructurally.

26980 (CONF-770504—, pp 159-165) **Morphology and ultrastructure of spermatozoa of the ticks.** Suleiman, S.A. (Univ. of Iowa, Ames); Brown, G.G. Oct 1977.

From 14. annual proceedings on electron microscopy; Ames, IA, USA (12 May 1977).

In Proceedings of the 14th annual electron microscopy colloquium.

Spermatozoa of both species are nonflagellated and club-shaped but varying in length: 140 μm in D. variabilis and 220 μm in D. andersoni. The spermatozoon consists of four regions: an apical motile organelle; a wide club region; a middle region; and a long posterior region containing most of the sperm structures. The entire spermatozoon is covered with longitudinal rows of cellular processes attached by short links. Motility is accomplished by the motile organelle and the flexible undulating cellular processes.

26981 (CONF-770504—, pp 166-171) **Ultrastructure of Babesia equi and the parasitized equine erythrocyte.** Barnett, D. (Burroughs Wellcome Co., Research Triangle Park, NC); Proctor, S.J.; Chieves, L. Oct 1977.

From 14. annual proceedings on electron microscopy; Ames, IA, USA (12 May 1977).

In Proceedings of the 14th annual electron microscopy colloquium.

Equine erythrocytes parasitized by Babesia equi were studied by transmission and scanning electron microscopy. Ultrastructural features common to other protozoa (pellicle, polar rings, rhoptries, refractile bodies, micronemes, and micropores) were discernible, but neither conoids nor mitochondria were recognized. Cytostomes were present and apparently were involved in hemoglobin ingestion. A tubule extending from the parasite to the erythrocyte plasmalemma apparently provided direct access to the blood plasma. Morphologic alteration of parasitized erythrocytes was limited to a distortion of cell shape and the presence of a few abnormal bodies in the cytoplasm.

PATHOLOGY

26982 (CONF-770504—, pp 43-59) **Myopathy associated with a murine Sarcocystic infection.** Viles, J.M.; Powell, E.C. (Iowa State Univ., Ames). Oct 1977.

From 14. annual proceedings on electron microscopy; Ames, IA, USA (12 May 1977).

In Proceedings of the 14th annual electron microscopy colloquium.

Myofiber degeneration which results from Sarcocystis infection exhibits a number of fine structural features suggestive of other myopathies and several well defined fine structural features not characteristic of other myopathies. Major alterations of the myofibrillar contractile apparatus occur at the periphery of the myofibrils bound parasitophorous vacuole which include splitting and fragmentation of the myofibrils at the longitudinal ends of the parasitophorous vacuole and Z line dissolution at the radial periphery. The basic features of myofibrillar degeneration resemble similar phenomena in a variety of diverse myopathies. Membranous structural elements including mitochondria, sarcoplasmic reticulum and T system components become disarrayed as the myofibrils degenerate. Some minor hypertrophy of the sarcoplasmic reticulum occurs in conjunction with initial fragmentation of the myofibrils but no major dilation or hypertrophy has been observed. There is a distinctive membranous organization of the interface of the parasitophorous vacuole which resembles features seen in intracellular stages of other coccidian protozoan infections. The presence of pincnotic and fragmenting nuclei, sarcolemmal invaginations with accompanying fibrous connective tissue invasion and large areas of undifferentiated cytoplasm suggest the ultimate necrosis and destruction of infected myofibers.

PHYSIOLOGICAL SYSTEMS

REFER ALSO TO CITATION(S) 26952, 26999

26983 (CONF-770504—, pp 72-87) **Challenge of pineal gland structure and function.** Knigge, K.M.; Joseph, S.A.; Piekut, D.T.; Hoffman, G.E. (Univ. of Rochester, NY). Oct 1977.

From 14. annual proceedings on electron microscopy; Ames, IA, USA (12 May 1977).

In Proceedings of the 14th annual electron microscopy colloquium.

Pineal glands of a number of vertebrates including monkey, rat, hamster, dog, guinea pig, gerbil, chicken and fish are being examined with respect to E.M. fine-structural correlates of in vitro indole production and secretion of a peptide hormone which inhibits the action of luteinizing-hormone-releasing factor (LRF). Indole synthesis varies widely; the rat pineal gland in culture produces nanomolar amounts per day, while hamster and guinea pig glands synthesize extremely small amounts. Responses to norepinephrine stimulation vary extensively and in some species (fish) the mechanisms of action may be different. E.M. examination of these glands indicates that there are at present no fine-structural correlates which reflect these wide ranges in indole synthesis. The anti-LRF substance appears to be a peptide with structure similar to LRF; it displaces antibody-bound ^{125}I-LRF in radioimmunoassay, competes with tissue antigen (LRF) in immunocytochemistry and can be visualized in pineal glands with fluorescein-labeled LRF antibody.

AGRICULTURE AND FOOD TECHNOLOGY

REFER ALSO TO CITATION(S) 26529, 26530

BIOMEDICAL SCIENCES, APPLIED STUDIES

RADIATION EFFECTS ON CELLS

EXTERNAL SOURCE

26984 (TID—28055) **Biological effects of ionizing radiation at the molecular, cellular, and organismal levels. Triannual progress report, July 15, 1974—October 14, 1977.** Lange, C.S. (Rochester Univ., N.Y. (USA). School of Medicine and Dentistry). 1977. Contract EY-76-S-02-3501. 16p. Dep. NTIS, PC A02/MF A01.

Progress is reported on the following studies: organization and repair of DNA; size measurement of DNA by means of the ultracentrifuge; effects of hydroxyurea, cycloheximide, and methylmercury on cell cycle progression; absence of an effect of photoreactivation on sublethal damage repair in a photoreactivating Wallaby cell line; and the control of differentiation and tissue polarity in planarians. (HLW)

BASIC STUDIES

REFER ALSO TO CITATION(S) 26977

RADIATION EFFECTS ON ANIMALS

MAN

REFER ALSO TO CITATION(S) 26419

26985 (SAND—77-1352C) **Competing risk model for reduction in life expectancy from radiogenic latent cancer.** Davis, H.T. (Sandia Labs., Albuquerque, N.Mex. (USA)). 1978. Contract EY-76-C-04-0789. 19p. (CONF-780306—1). Dep. NTIS, PC A02/MF A01.

From Symposium on late biological effects of ionizing radiation; Vienna, Austria (13 Mar 1978).

Because of the large number of persons who could potentially receive low doses of radiation as a result of a nuclear reactor accident, the number of fatalities from latent cancers is generally

larger than the early, or prompt, fatalities. For this reason the latent cancer fatality risk of reactor accidents is perceived as being more important than the early fatality risk. In addition, there exists the temptation to add the latent cancer fatality risk to the early fatality risk for the purpose of comparing reactor accident risks to other risks that society is exposed to, such as automobile accidents, airplane accidents, hurricanes, etc. However, the impact on the individual, and society as a whole, due to latent cancer fatalities is significantly different from the impact produced by early fatalities. Early fatalities generally result in appreciable life shortening for the affected individual while latent cancer fatalities generally result in very limited life shortening. A mathematical model was developed to express the reduction in life expectancy due to latent radiogenic cancer as a function of dose received.

VERTEBRATES

REFER ALSO TO CITATION(S) 26926, 26927, 26996

26986 (CONF-770504—, pp 16-23) **Ultrastructural characteristics of advanced radiation-induced adenocarcinoma in the small intestine of the rat.** Gruber, H.E.; Osborne, J.W. (Univ. of Iowa, Iowa City). Oct 1977.

From 14. annual proceedings on electron microscopy; Ames, IA, USA (12 May 1977).

In Proceedings of the 14th annual electron microscopy colloquium.

Tumors can be induced in the small intestine of Holtzman rats following exposure of hypoxic exteriorized small intestine to 2,000 R x-irradiation. The animal to be described was irradiated at two months of age. The presence of two 3 cm tumors was established at laparotomy four months post-irradiation. At sacrifice five months post-irradiation three advanced tumors were noted. This report will document ultrastructural changes in tumors, closely adjacent intestine, and intestine 20 cm from the pylorus. Changes in the epithelial mucosa involved alterations in the microvilli and mucous cells, and an apparent increase in desmosomes. Vascular hyperplasia, inflammatory cells in the regions and connective tissue changes leading to fibrosis will be described.

26987 (COO—3264-16) **Inborn anemias in mice. Progress report, 1 May 1976—31 July 1977.** Russell, E.S.; Bernstein, S.E. (Jackson Lab., Bar Harbor, Maine (USA)). 10 Aug 1977. Contract EY-76-S-02-3264. 21p. Dep. NTIS, PC A02/MF A01.

Hereditary anemias of mice have been the chief objects of investigation. At present under study are four macrocytic anemias, four hemolytic anemias, nonhemolytic microcytic anemia, transitory siderocytic anemia, sex-linked iron-transport anemia, and the autoimmune hemolytic anemia of NZB. Each of these blood dyscrasias is caused by the action of a unique mutant gene, which determines the structure of different intracellular molecules, and thus controls a different metabolic process. Thus our wide range of different hereditary anemias has considerable potential for uncovering many different aspects of hemopoietic homeostatic mechanisms in the mouse. Each anemia is studied through: characterization of peripheral blood values, determinations of radiosensitivity under a variety of conditions, measurements of iron metabolism and heme synthesis, histological and biochemical study of blood-forming tissue, functional tests of the stem cell component, examination of responses to erythroid stimuli, and transplantation of tissue between individuals of differently affected genotypes. Considerable effort is devoted to perfection of hematologic, cell culture, and transplant methods to make these techniques useful in dealing with special problems associated with abnormal function.

26988 (NTIS/PS—77/0753) **Radiation effects on cells and chromosomes (A bibliography with abstracts). Report for 1964—August 1977.** Crockett, P.W. (National Technical Information Service, Springfield, Va. (USA)). Sep 1977. 168p.

Reports on the effects of radiation on cell physiology, chemistry, and genetics are cited. Mechanisms of radiotherapy on cancerous cells are discussed. (This updated bibliography contains 163 abstracts, 30 of which are new entries to the previous edition.)

INVERTEBRATES

REFER ALSO TO CITATION(S) 26984

RADIONUCLIDE EFFECTS - INTERNAL SOURCE

MAN

26989 (BNWL—2207) **Detailed accident analysis for the high level waste preparation phase of the commercial nuclear waste vitrification project.** Oscarson, E.E.; Mishima, J.; Waite, D.A. (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). Apr 1977. Contract EY-76-C-06-1830. 46p. Dep. NTIS, PC A03/MF A01.

The environmental consequences and the probability of conceivable accidents occurring during the high level waste preparation (HLWP) phase of the Commercial Nuclear Waste Vitrification Project (CNWVP) were analyzed. The maximum environmental consequences of postulated accidents were calculated to result in low radiation doses: a 50-year dose commitment of 0.3 rem to the whole body for a maximum individual, and of 20 man-rem to the whole body for the surrounding population. This may be compared to Department of Energy (DOE) values, in Manual Chapter Appendix 0524, of 0.5-rem whole-body annual dose commitment to individuals at points of maximum probable exposure in uncontrolled areas. The calculated whole-body relative dose risk to individuals from accidents is low (1.6×10^{-6} rem/yr) as compared to that received from natural background radiation (approximately 1.5×10^{-1} rem/yr) and as compared to levels specified in Nuclear Regulatory Commission (NRC) requirements for routine releases from nuclear power reactors (5.0×10^{-3} rem/yr). Therefore, the design and operation plans for the HLWP phase are judged not to represent an undue environmental risk from accident conditions.

NUCLIDE KINETICS AND TOXICOLOGY

26990 (NTIS/PS—77/1011) **Ecosystem models. Volume 2. November 1975—November 1977 (a bibliography with abstracts).** Harrison, E.A. (National Technical Information Service, Springfield, Va. (USA)). Nov 1977. 186p. NTIS PC N01/MF N01.

The preparation and use of ecosystem models are covered in this bibliography of Federally-funded research. Models for marine biology, wildlife, plants, water pollution, microorganisms, food chains, radioactive substances, limnology, and diseases as related to ecosystems are included. (This updated bibliography contains 181 abstracts, 105 of which are new entries to the previous edition.)

MAN

REFER ALSO TO CITATION(S) 26972, 26985, 26998

26991 (IAEA-SM—222/51) **Standardized radioactive decay data sets for use in radiation dosimetry.** Kocher, D.C.; Ewbank, W.B.; Martin, M.J. (Oak Ridge National Lab., Tenn. (USA)). 1977. Contract W-7405-ENG-26. 8p. (CONF-771209—8). Dep. NTIS, PC A02/MF A01.

From IAEA symposium on national and international standardization of radiation dosimetry; Atlanta, GA, USA (5 Dec 1977).

A computer-based system for obtaining the energies and intensities of radiations from radionuclide decays in a format suitable for application to radiation dosimetry calculations is described. The system is based on radionuclide decay data written in the format of the Evaluated Nuclear Structure Data File (ENSDF). These data are processed with the computer code MEDLIST, which produces listings of the energies and intensities of the radiations in tabular form and in a decimal, computer-readable format. Collections of radionuclide decay data which have been prepared for publication from ENSDF by the MEDLIST code and applications of these data to radiation dosimetry calculations are discussed.

26992 (PNL—2439) **Population dose commitments due to radioactive releases from nuclear power plant sites in 1975.** Baker, D.A.; Soldat, J.K.; Watson, E.C. (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). Oct 1977. Contract EY-76-C-06-1830. 133p. Dep. NTIS, PC A07/MF A01.

Population radiation dose commitments were estimated from reported radionuclide releases from commercial power reactors operating during 1975. Fifty-year dose commitments from one year exposure were calculated from both liquid and atmospheric releases for four population groups (infant, child, teenager and adult) residing between 2 and 80 km from each site. Results are given in the form of tables giving the dose commitments for both liquid and airborne pathways for each age group and organ. Also included for each site is a histogram showing the fraction of the total population within the 2 to 80-km region around each site receiving various average dose commitments from the airborne pathways. The total dose commitment from both liquid and airborne pathways ranged from a high of 750 person-rem to a low of 0.008 person-rem with an arithmetic mean of 34 person-rem.

26993 (UCLA—12-1142) **Investigation of ^{18}F-2-deoxyglucose for the measure of myocardial glucose metabolism.** Phelps, M.E.; Hoffman, E.J.; Selin, C.; Huang, S.C.; Robinson, G.; MacDonald, N.; Schelbert, H.R.; Kuhl, D.E. (California Univ., Los Angeles (USA). Lab. of Nuclear Medicine and Radiation Biology). 1977. Contract EY-76-C-03-0012. 34p. Dep. NTIS, PC A03/MF A01.

^{18}F labeled 2-deoxyglucose (^{18}FDG) was studied as a glucose analog. Myocardial uptake and retention, blood clearance, species (dog, monkey, man) dependence and effect of diet on uptake were investigated. Normal myocardial uptake of ^{18}FDG was 3 to 4% in

dog and monkey and 1 to 4% of injected dose in man compared to brain uptake of 2% in dog, 5 to 6% in monkey and 4 to 8% in man. The metabolic rate (MR) for glucose in non-fasting (glycolytic state) was 2.8 times greater than in fasting (ketogenic state). Human subjects showed higher myocardial uptake after a normal meal than after meal containing mostly free fatty acids (FFA). Blood clearance was rapid with initial clearance $t^1/_2$ of 0.2 to 0.3 min followed by a $t^1/_2$ of 8.4 +- 1.2 min in dog and 11.6 +- 1.1 min in man. A small third component had a $t^1/_2$ of 59 +- 10 min and 88 +- 4 min in dog and man, respectively. High image contrast ratios between heart and blood (dog 3.5/1; man 14/1), heart and lung (dog 9/1; man 20/1), heart and liver (dog 15/1; man 10/1) were found with the ECAT positron tomograph. ^{18}FDG was found to be rapidly taken up by the myocardium without any significant tissue clearance over a 4 hour period. ^{18}FDG is transported, phosphorylated to ^{18}FDG-6-PO_4 and trapped in myocardial cells in the same manner as has been found for brain and exhibits excellent imaging properties. Determination of glucose and FFA MR in vivo with ECT provides a method for investigation and assessment of changing aerobic and anaerobic metabolic rates in ischemic heart disease in man.

ANIMALS

REFER ALSO TO CITATION(S) 26909, 26912, 26913, 26914, 26915, 26993

PLANTS

REFER ALSO TO CITATION(S) 26909, 26912

MICROORGANISMS

REFER ALSO TO CITATION(S) 26916

CHEMICALS METABOLISM AND TOXICITY

MICROORGANISMS

REFER ALSO TO CITATION(S) 26011

PLANTS

26994 (ORNL/EMIC—9) **Literature survey of bacterial, fungal, and Drosophila assay systems used in the evaluation of selected chemical compounds for mutagenic activity.** Brown, M.M.; Wassom, J.S.; Malling, H.V.; Shelby, M.D.; Von Halle, E.S. (Oak Ridge National Lab., Tenn. (USA)). Dec 1977. Contract W-7405-ENG-26. 92p. Dep. NTIS, PC A05/MF A01.

Literature reports were surveyed for results obtained from experiments in seven nonmammalian assay systems used for the detection of mutagenicity or other related genetic effects. A comparison was made among the activities of 53 selected noncarcinogens, procarcinogens, and ultimate carcinogens as revealed by these test systems. Forty-eight (91 percent) of the compounds tested were active in one or more of the assays, and 42 (79 percent) were positive in at least one system without being metabolically activated. Sixteen of 17 ultimate carcinogens (94 percent), 26 of 27 procarcinogens (96 percent), and 6 of 9 noncarcinogens (67 percent) were positive in one or more test systems. The most discriminating system was the Ames Salmonella/microsome assay, which responded with increased mutation frequency to 37 of 43 carcinogenic compounds (86 percent) but to only 2 of 8 noncarcinogens tested (25 percent). The Drosophila system responded to 95 percent of the carcinogens and to 50 percent of the noncarcinogens. Prophages were induced when lysogenic bacteria were exposed to 12 of the 21 carcinogens (57 percent), but not enough tests were made with the noncarcinogens [1 of 3 (33 percent)] for a comparison. The other systems reviewed, such as the killing of repair-deficient bacteria and mutations in Escherichia coli, Neurospora crassa, and the host-mediated assay, were not challenged by enough of the compounds for valid comparisons.

INVERTEBRATES

REFER ALSO TO CITATION(S) 26994

VERTEBRATES

REFER ALSO TO CITATION(S) 26994

26995 (CONF-771147—2) **Comparative metabolism of benzo(a)pyrene in rodent liver and embryonic cells in tissue culture.** Selkirk, J.K.; Wiebel, F.J. (Oak Ridge National Lab., Tenn. (USA); Gesellschaft fuer Strahlen- und Umweltforschung m.b.H., Clausthal-Zellerfeld (Germany, F.R.). Inst. fuer Tieflagerung). 1977. Contract W-7405-ENG-26. 22p. NTIS, MF A01.

From Symposium on the Syrian hamster in toxicology; Cambridge, MA, USA (30 Nov 1977).

High Pressure Liquid Chromatography has been utilized to separate and compare benzo(a)pyrene activation and detoxification products between rat, mouse, and hamster hepatic microsomes and mouse and hamster embryo cell cultures. While metabolite profiles exhibited the same type of derivatives, marked quantitative variation was observed. Microsomal preparation produced large amounts of noncarcinogenic phenols, while intact cell metabolism favored diol formation. These results are in agreement with reactivation of metabolic diols as substrates for further activation to a more proximate carcinogenic species of benzo(a)pyrene and cautions against extrapolating metabolic results from any single test system to other species or tissues.

26996 (TID—28142) **Procedures for the detection of unscheduled DNA synthesis in the germ cells of mole mice exposed in vivo to chemical mutagens.** Sotomayor, R.E. (Oak Ridge National Lab., Tenn. (USA)). 1977. Contract W-7405-ENG-26. 10p. (In Spanish). Dep. NTIS, PC A02/MF A01.

Procedures are described for measurement of the rate of synthesis of DNA in germ cells of male mice following in vivo exposure to x radiation or several chemical mutagens, including EMS, MMS, CPA, and DMO. The uptake of ^{3}H-dt by cells sampled during spermatogenesis was used as the indicator of DNA synthesis in experimental animals and controls.

MAN

REFER ALSO TO CITATION(S) 26894, 26994

26997 (LA—7058-PR) **Development of sampling and analytical methods for carcinogens. Progress report, January 1—September 30, 1976.** Morales, R.; Rappaport, S.M.; Weeks, R.W. Jr.; Campbell, E.E.; Ettinger, H.J. (Los Alamos Scientific Lab., N.Mex. (USA)). Dec 1977. Contract W-7405-ENG-36. 29p. Dep. NTIS, PC A03/MF A01.

Components used for the generation of aerosols and vapors of certain aromatic amines on the Occupational Safety and Health Administration list of carcinogens are described. A two-stage sampling tube incorporating a glass fiber filter followed by silica gel was developed for collecting aerosols of benzidine and 3,3'-dichlorobenzidine. For α- and β-naphthylamine, a similar sampler having a greater capacity for retaining vapors was developed. Efficient desorption and sensitive analytical procedures for the quantitative determination of these four amines are described. Results of respirator canisters evaluated for protection against 4,4'-methylenebis(2-chloroaniline) and the naphthylamines are given.

26998 (UCID—17673) **Hazard analysis of uranium inhalation at the Lawrence Livermore Laboratory.** King, W.C. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 5 Dec 1977. Contract W-7405-ENG-48. 10p. Dep. NTIS, PC A02/MF A01.

This paper is a study on the adequacy of the routine bioassay program conducted at the Lawrence Livermore Laboratory to detect and quantify an inhalation exposure to uranium which may have gone undetected by the other usual monitoring methods. The LLL AERIN computer code was used to calculate the maximum organ burdens and dose equivalents which could exist at the minimum detectable level of uranium in the urine and the lung. Acute and chronic inhalation exposures were investigated for each of the three ICRP solubility classes, "D," "W", and "Y". The study showed that a routine semiannual urinalysis for uranium would detect 35% of a maximum permissible lung burden resulting from an acute exposure to "Y" class uranium when the sample was collected 200 days after the exposure. This was considered the worst-case that could exist. Kidney burdens were compared to the chemical toxicity threshold limit of 3 mu g of uranium/g of kidney tissue. The value of conducting routine in vivo lung counts for uranium is questionable.

OTHER ENVIRONMENTAL POLLUTANT EFFECTS

26999 (AD-A—043457) **Research on the ocular effects of laser radiation. Final report, 16 February 1975—30 November 1976.** Zuclich, J.A.; Yates, J.T.; Nawrocki, A.D.; Bowie, W.H.; Lemberger, R.F. (Technology, Inc., San Antonio, Tex. (USA). Life Sciences Div.). 5 Aug 1977. Contract F41609-73-C-0017. 207p. (TI—77-0561-03). NTIS PC A10/MF A01.

Contents: Ocular Effects of Visible and Near-Infrared Laser Radiation -- Large Retinal Lesions, Retinal Photochemistry, In Vivo Retinal Probe Experiments, Effects of Laser Radiation on Retinal Lipids, and Ocular Histopathology and Electron Microscopy; Ocular Effects of Ultraviolet Laser Radiation -- Corneal Damage Induced by Near-UV Laser Radiation, Oxygen Dependence of Near-UV Induced Corneal Damage, Action Spectrum for Near-UV

Induced Corneal Damage, and Lenticular Effects of Near-UV Laser Radiation; Neurophysiology and Physiological Optics -- Visual Evoked Response, and Physiological Optics.

27000 (AD-A—043458) **Biological effects of nonionizing electromagnetic radiation. Volume II, Number 1. A digest of current literature. Quarterly report June—September 1977.** Kleinstein, B.H.; Saboe, E.P. (Franklin Inst. Research Labs., Rockville, Md. (USA). Science Information Services Dept.). Sep 1977. 37p. NTIS PC A03/MF A01.

This quarterly digest presents current awareness information on the biological effects of nonionizing electromagnetic radiation (Microwave and radiofrequency) in the range of 0 Hz to 100 GHz. The effects of magnetic and electric fields (static and alternating) are also covered. Each issue contains abstracts of English and foreign current literature, summaries of ongoing research investigations, new items, and a directory of meetings and conferences.

27001 (AD-A—043706) **Operant behavior and colonic temperature of squirrel monkeys (saimiri sciureus) during microwave irradiation. Interim report.** de Lorge, J. (Naval Aerospace Medical Inst., Pensacola, Fla. (USA)). 8 Jun 1977. 33p. (NAMRL—1236). NTIS PC A03/MF A01.

Contemporary reports in the scientific and popular press of potentially hazardous effects of exposure to microwaves require substantiation because some Navy personnel contact a variety of microwave devices in communication, warning and weapons systems. Such putative effects preclude the use of man as a subject; hence, a series of experiments with other primates, monkeys, has been initiated. Research in our laboratory has established that microwave irradiation greater than 62 mW/sq cm disrupts behavior in rhesus monkeys. In an effort to extend the generality of this finding, squirrel monkeys are exposed to microwaves. The behavior of squirrel monkeys on a vigilance task was disrupted by 30- or 60-minute exposures to 50 mW/sq cm and higher power densities. This disruption increased with the increase in power density. Under both durations of exposure, behavior was not consistently perturbed until colonic temperature changes exceeded 1 C. Colonic temperatures regularly increased beginning at 10 mW/sq cm and were related in a nonlinear fashion to the power density with a marked acceleration between 40 and 50 mW/sq cm.

27002 (SLAC-PUB—1984) **Biomagnetism: a review.** St. Lorant, S.J. (Stanford Linear Accelerator Center, Calif. (USA)). Jul 1977. Contract EY-76-S-03-0326. 9p. (CONF-770842—18). Dep. NTIS, PC A02/MF A01.

From 6. international conference on magnet technology; Bratislava, Czechoslovakia (29 Aug 1977).

Certain authenticated biological effects of static and low frequency magnetic fields are reviewed, and the potential hazards associated with human exposure are discussed. It is concluded that, in spite of the considerable amount of experimental work which has been done in the field of biomagnetics, our understanding of the effect which magnetic fields have on an organism and in particular on the human body remains rudimentary. We can deduce from past experience that by and large the magnetic effects are fully reversible once the organism is permitted to return to its original environment. No experimental evidence exists which would indicate a cumulative effect caused by repeated exposures without adequate recovery times between exposures. Answers to these questions can come only from carefully conducted experiments which not only closely simulate such exposures and look for physiological, psychological, and pathologic changes, but also recognize that man is an exceedingly complex mechanism and that the cause and effect relationship due to the magnetic field may be completely masked by unrelated but competing processes.

HEALTH AND SAFETY

REFER ALSO TO CITATION(S) 26933

GEOSCIENCES

GEOLOGY AND HYDROLOGY

REFER ALSO TO CITATION(S) 25817, 26896, 26900

27003 (ORNL/NSF/EATC—29) **Corrections and revisions to the FORTRAN IV version of the Wisconsin Hydrologic Transport Model.** Munro, J.K.; Huff, D.D. (Oak Ridge National Lab., Tenn. (USA)). May 1977. Contract W-7405-ENG-26. 42p. NTIS, PC E02/MF A01.

Since publication of the WHTM user's manual in 1974, several useful adjustments to the program have been implemented. They include corrections to syntax, incorporation of effects of forest litter on contaminant transport, corrections to include conservation of mass in the theoretical plate ion-exchange algorithms, reintroduction of ion-exchange processes in subsurface soils, and the inclusion of some diagnostic print options. A description of each change has been presented, together with a comprehensive example of the results obtained when the revised WHTM is used. Thus, this report updates older versions of the WHTM.

27004 (TID—26712, pp 1-11) **Geographic setting.** Merritt, M.L. (Sandia Labs., Albuquerque, NM). Sep 1977.

In Environment of Amchitka Island, Alaska.

Amchitka Island lies at latitude 51.5°N and longitude 179°E. It is one of the Rat Island Group of the Aleutian Islands, Alaska, which comprises the emergent part of a long submarine ridge connecting North America and Asia and separating the Bering Sea from the North Pacific Ocean. Amchitka is almost the southernmost Aleutian Island, only nearby Amatignak being farther south. It is thus almost the southernmost point in Alaska. Amchitka is 2160 km (1340 statute miles) west-southwest of Anchorage, Alaska, and 4000 km (2500 miles) west-northwest of Seattle, Wash. It is almost half the way from North America to Asia, being 1400 km (870 miles) east of Petropavlovsk, Kamchatka, U.S.S.R., and 1230 km (765 miles) west of the tip of the Alaskan mainland at False Pass. Amchitka and all the Aleutian Islands except a few of the easternmost ones are in the Aleutian Islands National Wildlife Refuge. All the investigations reported in this volume except for a few (e.g., sea otter and oceanographic studies) were carried out on Amchitka or in the nearby sea.

27005 (TID—26712, pp 13-34) **Geologic history.** Gard, L.M. Jr. (Geological Survey, Denver). Sep 1977.

In Environment of Amchitka Island, Alaska.

Amchitka Island is one of the most southerly islands in the Aleutian Island arc. In general terms its geologic history is probably representative of most of the Aleutian Islands. Three distinct volcanic episodes have been recognized and dated by fossil evidence and by radiometric dating. The oldest of these is early Tertiary, probably Eocene, and is represented by altered basic to intermediate submarine lavas and volcanic debris. Next, coarse turbidities and other sediments of basaltic debris shed from nearby volcanoes were deposited on the sea floor during late Eocene or early Oligocene time. After a period of uplift, tilting, faulting, erosion, and invasion by small dioritic plutons in mid-Tertiary time, a subaerial volcanic complex of andesitic composition was constructed during the Miocene. At that time the island probably stood higher above sea level than at present and trees were common. This volcanic complex is probably genetically related to one of the Miocene plutons. During Pliocene time minor shallow basaltic and horn-blende andesitic intrusions occurred. In early Pleistocene time the island was still above sea level, the climate was somewhat warmer than now, and trees were present. During glacial and interglacial episodes, sea level fluctuated. During glacial periods terraces were carved as much as 91 m below sea level, and deposits of two episodes of glaciation are preserved. During interglacial times flights of marine terraces were cut above present sea level, and marine deposits on the island are correlated with two of them. Tensional faulting continued into Wisconsinan time; however, the island appears to have been tectonically stable during the past 2000 to 4000 years.

27006 (UCRL—52348) **Iterative reconstruction of underground refractive index distributions from cross-borehole transmission data.** Dines, K.A.; Lytle, R.J. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 2 Nov 1977. Contract W-7405-ENG-48. 11p. Dep. NTIS, PC A02/MF A01.

A description of the structures in an underground area to be surveyed can help reduce the dangers and costs of excavation. Underground electromagnetic or acoustic probing from boreholes provides the data for calculating refractive index distributions that characterize the structure. In this report, we present a computerized method for calculating the refractive index distribution between two underground boreholes. This scheme inverts cross-borehole transmission data by combining techniques of numerical-ray tracing with smoothness-constrained linear system inversion. Computer studies show this method to be convergent in the presence of data noise for refractive index differences up to 30 percent. Results indicate that we can substantially improve the reconstruction quality with iterative ray tracing.

GEOPHYSICS

SEISMOLOGY AND TECTONICS

REFER ALSO TO CITATION(S) 27018

27007 Structural knots: important elements of structural boundaries of ancient platforms. Stavtsev, A.L. *Int. Geol. Rev.;* **19**: No. 7, 859-868(Jul 1977).

Translated from Sov. Geol.; No. 5, 32-44(1976).

A special type of ancient platforms is the structural knot, formed by deep-seated tectonic zones. In contrast to other structures of the platform boundaries, structural knots are nonlinear, more or less isometric, and are characterized by the absence of linear orientation of the internal structural elements. The structural and metallogenic characteristics of the Colorado and the Uchur-Maya structural knots, and their similarities and differences, are presented. Structural knots represent marginal zones of ancient platforms that have undergone intense tectonomagmatic activation. Their most important feature is the variety of mineral resources which, in all probability, has been determined by the superimposition of the metallogenic features of the platforms, mobile belts, and intense ore-forming processes associated with tectonomagmatic activation. The richness in mineral deposits of the well-studied Colorado knot raises the question of the necessity for a detailed study of analogous structures in the junction zones between ancient platforms and mobile belts of other regions of the globe.

VOLCANOLOGY

REFER ALSO TO CITATION(S) 26123

27008 Possible association between intensity of modern volcanism and horizontal movements of the crust in eastern Kamchatka. Suprunenko, O.I. *Int. Geol. Rev.;* **19**: No. 8, 947-950(Aug 1977).

Translated from Sov. Geol.; No. 10, 132-136(1976).

It is suggested that the high activity of the Klyuchevsk group of volcanoes is dependent on its location in the rear of the most "compressed" part of the Eastern Kamchatka graben-synclinorium. Compression of the synclinorium, controlled by the movement of rock masses in an easterly direction, began in pre-Neogene or, at least, during Late Miocene time and is continuing at the present time.

27009 Rare earth and other trace elements in historic Azorean lavas. Flower, M.F.J. (Univ., Bochum, Ger.); Schmincke, H.U.; Bowman, H. *J. Volcanol. Geotherm. Res.;* **1**: No. 2, 127-147(Sep 1976).

Rare earth element (REE) and other trace element compositions of 16 lavas from all historic and 2 prehistoric eruptions on 5 islands of the Azores Archipelago show notable intra- and inter-island differences. Fe enrichment and "compatible" element depletion due to fractional crystallization have been superimposed on variations established in the source area. Fractionation of La/Sm, U/Th, K/Na and "large ion lithophile" (LIL) element abundances are probably related to variable fusion of a source peridotite whose LIL element distribution cannot be exactly specified in view of its possible heterogeneity. Relative light-REE enrichment in basalt appears greatest on the "potassic" island Sao Miguel, the more sodic island Fayal and one lava from Pico, and least in basalts from the "sodic" islands Terceira, Sao Jorge and Pico. This variation is matched by most other LIL elements, although P shows unexpected enrichment in Terceira lavas, otherwise the least LIL element-enriched and most heavy-REE-enriched. Upper mantle phase chemistry is probably critical in establishing the patterns. In particular, P—REE covariance may reflect phase stabilities of apatite and (P-bearing) garnet in the upper mantle. Distribution patterns of REE in the historic lavas are similar to those of basalts from the Atlantic median rift at the crest of the Azores "platform". Transition to light-REE-depleted rift-erupted basalts to the southwest is believed to be step-wise with increasing water depth, possibly indicating retention of a light-REE-rich phase in the residue from partial fusion as intersection of geotherm and peridotite solidus occur at lower pressures. The source mantle for the Azores basalts is probably light-REE- and LIL element-enriched, but no evidence was found to suggest its emplacement by thermal "plume" activity.

GEOPHYSICAL SURVEY METHODS

REFER ALSO TO CITATION(S) 25735, 27006

27010 Design of discrete nonadaptive operators for seismic data processing. Peacock, K.L. Tulsa, OK; Univ. of Tulsa (1977). 132p. University Microfilms Order No. 77-17,258.

Thesis (Ph. D.).

The mathematical formulation of certain discrete operators that are useful for the filtering of seismic data is presented. The operators are of the nonadaptive type (i.e., they are independent of input signals) and are constructed by the inverse Fourier transform. Formulas and graphs to aid in operator length selection are given, based on envelope decay of the operators. This approach in conjunction with the ideal highcut filter design results in a flexible approach to bandpass filtering where operators can be constructed based on their final response rather than initial response. Operators for differentiation and integration are formulated for discrete signals. In particular, the integration operator is constructed to have an ideal performance characteristic. This is, the length is chosen such that the amplitude-vs-frequency response has minimal error over the frequency band of interest. Operators for such objectives as Hilbert transformation, constant-phase filtering, interpolation, and sample skewing are all useful at times. It is interesting to note that the sample skew operator will also do simple interpolation in about $1/4$ the time normally required. The operators are applied to synthetic test signals to illustrate typical applications and to check the numerical accuracy that can be expected. The synthetic data produce results that exhibit between 3 and 6 significant digits of accuracy.

27011 Dynamic range of reflection recording in seismic exploration. Gurvich, I.I. *Int. Geol. Rev.;* **18**: No. 2, 233-235(Feb 1976).

Translated from Razved. Geofiz.; No. 60, 3-8(1973).

A few simple relations are systematically deduced for the estimate of total dynamic range that exists in reflection seismics and must be handled by the recording channel. The shortcomings of analog recording are overcome by digital recording. This aspect is seen as one of the virtues of the digital approach.

27012 Application of CDP-stacked tapes to seismic exploration. Mironov, V.Ya. *Int. Geol. Rev.;* **18**: No. 2, 236-242(Feb 1976).

Translated from Razved. Geofiz.; No. 57, 37-46(1973).

The procedure of obtaining CDR (controllable directional reception) tapes based on stacking according to the CDP a(common depth point) method is examined. Starting with a particular form of the traveltime curve, one converts it into the approximate CDP traveltime characteristic in terms of the normal movement at the distance corresponding to the common depth point. It is further demonstrated that the influence of dipping boundaries for the CDP traveltime curve is considerably reduced as compared to that for conventional traveltime curves. To obtain the initial CDP tapes, one must employ multiple tracking with high multiplicity (about 14). This procedure amounts to a proliferation of common traces and permits the use of conventional CDP observations. The moveout graphs, obtained from CDP-stacked tapes, become the input data for the determination of other kinematic parameters. It is shown how, using CDP-stacked tapes, one can compute the effective, average, and formation velocities of the medium. For regions where CDP is employed, conventional methods for determination of velocities are of little use because of wave interference. This situation is combatted by stacking of CDR seismic traces, selected according to the CDP principle. The treatment is in terms of a set of simple mathematical statements.

MINERALOGY, PETROLOGY, AND ROCK MECHANICS

REFER ALSO TO CITATION(S) 25697, 25698, 25699, 25940

27013 (PB—269706) Minerals yearbook 1974. Volume III. Area reports: international. (Bureau of Mines, Washington, D.C. (USA)). 1977. 1245p. (BM-MYB—1974(Vol.3)). NTIS PC A99/MF A01.

The latest available statistics are presented for more than 150 countries and areas. The importance of minerals to the economies of these nations is discussed. A separate chapter reviews minerals in the world economy.

27014 (UCRL—13795) Effect of principal stress magnitudes on hydrofracturing orientation. Final report. Haimson, B.C. (Wisconsin Univ., Madison (USA). Dept. of Metallurgical and Mineral Engineering). Dec 1977. Contract W-7405-ENG-18. 20p. Dep. NTIS, PC A02/MF A01.

Reports are reported for 23 tests in Montello granite conducted to verify the effect of the vertical stress magnitude on hydrofracture orientation. It was found that so long as the vertical stress is smaller than the least horizontal compressive stress there is a good probability that the hydrofracture, which initiates vertically at the borehole, will rotate and become horizontal as it extends away. Thirty-one tests were conducted to investigate the effect of the difference (sigma/sub Hmax/ to sigma/sub Hmin/) on the orientation of the hydrofracture. In these tests the vertical stress was kept higher than sigma/sub Hmin/. The results show that hydrofractures are vertical and parallel to sigma/sub Hmin/ so long as sigma/sub Hmax/ to sigma/sub Hmin/ >75 psi, which attests to the sensitivity of the hydrofracture direction to the principle of the path of least resistance.

GEOCHEMISTRY

REFER ALSO TO CITATION(S) 25922

27015 (LA—6987-MS) **Geochemical dispersion at the Mother Lode Mine near Kennicott, Alaska.** Linn, G.W. (Los Alamos Scientific Lab., N.Mex. (USA)). Oct 1977. Contract W-7405-ENG-36. 15p. Dep. NTIS, PC A02/MF A01.

Analysis for elements substituting in the crystal lattice of major carbonate minerals and indium, selenium, and thallium has defined two geochemical dispersion groups away from the Mother Lode massive chalcocite ore body near Kennicott, Alaska. The first group is characterized by inverse logarithmic gradients of concentrations of some elements. These gradients decrease to background concentration values approximately 15 m from the contact of the ore with the wall rock, indicating that this zone is one of intense mass transfer associated with ore deposition. The zones are local exploration indicators of proximity to ore. The second group has halos of some elements at discrete distances much farther from the ore body. The most prominent halo occurs at 480 m and the farthest about 1 km from the ore body, providing regional exploration indicators of chalcocite veins. Comparisons of these dispersion patterns with those surrounding other ore deposits show, despite differences in systems, similarities in the distances of related mass transfer.

27016 (LA-UR—77-2818) **Uranium solubilities in the Oklo reactor zones.** Duffy, C.J. (Los Alamos Scientific Lab., N.Mex. (USA)). 1977. Contract W-7405-ENG-36. 9p. (CONF-771222—5). Dep. NTIS, PC A02/MF A01.

From IAEA symposium on natural fission reactors; Paris, France (19 Dec 1977).

It was hypothesized that uraninite grains in the reactor zones at Oklo (Gabon) might show zonation with respect to the isotopic composition of the uranium. A more nearly natural composition might be expected in the rims of such grains since solutions moving into the reactor zones from the undepleted ore zone would carry natural uranium. Several uraninite grains were examined by means of an ion microprobe capable of resolving a rim of 10 microns width. Within the approximately 5% precision of the instrument no zoning was detected. The absence of detectable zoning in the isotopic compositions of the uraninite grains might be caused by low solubility of uraninite in the Oklo ore body resulting in insignificant uranium transport. That this is a reasonable assumption is borne out by solubility calculations for uraninite in equilibrium with uranium ions and uranium oxide, hydroxide, and carbonate ions in aqueous solution. These calculations indicate that if 0_2 and CO_2 are in equilibrium with the solid assemblage magnetite, hematite, and graphite total uranium molalities in the pH range from 5 to 6.8 are less than 10^{-9}. Under these conditions, and assuming no other important aqueous uranium species, uranium transport would be insufficient to produce observable zoning in the reactor zone uraninite.

27017 (UCRL—52295(Pt.2)) **Automation of the national water quality laboratories, U.S. Geological Survey 2: design concepts for achievement of automation objectives.** Ames, H.S.; Morris, W.F. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 30 Jun 1977. Contract W-7405-ENG-48. 44p. Dep. NTIS, PC A03/MF A01.

A three-computer system is proposed for the two National Water Quality (NWQ) laboratories in Denver, Colorado, and Atlanta, Georgia. In each laboratory, two computers will service on-line automated instrumentation and off-line data entry. The third computer will handle sample data management and other functions required to log in samples, assign analyses, store results, and generate sample analysis reports. The design also includes backup features to preserve accumulated sample data and provide continued laboratory operations in the event of component failure. Hardware and software configurations as well as projected system performance and utilization are presented.

27018 (USGS-OFR—77-724) **Chemical data and variation diagrams of igneous rocks from the Timber Mountain-Oasis Valley, Caldera Complex, southern Nevada.** Quinlivan, W.D.; Byers, F.M. Jr. (Geological Survey, Washington, D.C. (USA)). 1977. Contract EY-76-A-08-0474. 89p. Dep. NTIS, PC A05/MF A01.

Silica variation diagrams presented here are based on 162 chemical analyses of tuffs, lavas, and intrusives, representative of volcanic centers of the Timber Mountain-Oasis Valley caldera complex and cogenetic rocks of the Silent Canyon caldera. Most of the volcanic units sampled are shown on the U. S. Geological Survey geologic map of the Timber Mountain caldera area (I-891) and are described in U. S. Geological Survey Professional Paper 919. Early effusives of the complex, although slightly altered, are probably chemically, and petrographically, more like the calc-alkalic Fraction Tuff (Miocene) of the northern Nellis Air Force Base Bombing and Gunnery Range to the north, whereas effusives of later Miocene age, such as the Paintbrush and Timber Mountain Tuffs, are alkali-calcic.

27019 (UCRL-Trans—11309) **Use of neutron—gamma logging data normalized from readings in a reference borehole to estimate the volume water content of carbonate rocks.** Larionov, V.V.; Shvartsman, M.D. Nov 1977. Translated from Geofiz. Issled. Neft. Gazov. Skvazhin, pp 139-142(1971). 9p. Dep. NTIS, PC A02/MF A01.

Data are reported on the water content of carbonate rocks of the Steppe Crimea region determined by neutron-gamma logging and data on porosity.

27020 **New energy-related uses for lithium encourages search for new sources.** Vine, J.D.; Brenner-Tourtelot, E.F. (U.S. Geological Survey, Denver). pp 407-411 of Exploration frontiers of the central and southern Rockies. Veal, H.K. (ed.). Denver; Rocky Mountain Association of Geologists (1977).

From Symposium program RMAG fall field conference; Snowmass, CO, USA (29 Sep 1977).

See CONF-770972—.

The demand for lithium to use in making batteries may rise dramatically within the next few decades. The light weight and high electrical potential of lithium make lithium batteries attractive for use in electric automobiles and for load-leveling and storage of electricity. Lithium requirements for thermonuclear power generation in the next century are also potentially huge. Therefore the U.S. Geological Survey is reassessing lithium resource estimates. Although large reserves of lithium are known in the spodumene-bearing pegmatites in North Carolina, the best chance of finding additional resources is probably in the southwestern United States. Large, low-grade deposits of lithium may occur in sedimentary rocks and brines associated with evaporites, especially nonmarine evaporites in closed basins. Volcanic and thermal spring activity is thought to be related to the concentration of lithium in young sediments and brines in the Southwest.

OCEANOGRAPHY

REFER ALSO TO CITATION(S) 26930

27021 (TID—26712, pp 331-352) **Oceanography.** McAlister, W.B.; Favorite, F. (National Marine Fisheries Service, Seattle). Sep 1977.

In Environment of Amchitka Island, Alaska.

Circulation near Amchitka Island is influenced by complex patterns of exchange and mixing between the North Pacific Ocean and Bering Sea waters in the passes of the Aleutian Islands, resulting in wide variations in physical, chemical, and biological conditions seasonally, and also over short geographic distances. Strong westward flow in the Alaskan Stream south of Amchitka Island brings water of 2 to 4°C into the area in winter, ameliorating sea and air temperatures and inhibiting the development of extensive shore ice. During spring and summer, coastal turbulence reduces thermal stratification in the surface layer, and inshore water temperatures are 1 to 4°C lower than in the offshore oceanic regimes. Zooplankton are typical subarctic Pacific forms. Zooplankton volumes in the 0- to 150-m surface layer increased roughly one order of magnitude from winter to summer. Nutrients do not appear to be limiting for phytoplankton growth.

PHYSICS RESEARCH

ASTROPHYSICS AND COSMOLOGY

REFER ALSO TO CITATION(S) 27200

COSMIC RADIATION

REFER ALSO TO CITATION(S) 27134

STARS

27022 **Cepheid pulsation theory and multiperiodic Cepheid variables.** Cox, A.N. (Los Alamos Scientific Lab., N.Mex. (USA)); Cox, J.P. (Joint Inst. for Lab. Astrophysics, Boulder, Colo. (USA)). pp 115-131 of Multiple periodic variable stars. Proceedings of the International Astronomical Union colloquium no. 29 held at Budapest, Hungary, 1 - 5 September 1975. Fitch, W.S. (ed.) (Arizona Univ., Tucson (USA)). Dordrecht, Netherlands; D. Reidel (1976).

From 29. colloquium of the I.A.U. multiple periodic variable stars; Budapest, Hungary (1 Sep 1975).

See CONF-750940—.

In this review of the situation with regard to the multiperiodic Cepheid variables, the subject matter is divided into four parts. The first discusses general causes of pulsation of Cepheids and other variable stars, and their locations on the H-R diagram. In the second section the linear adiabatic and nonadiabatic theory calculation of radial pulsation periods and their application to the problem of

masses of double-mode Cepheids are reviewed. Periodic solutions, and their stability, of the nonlinear radial pulsation equations for Cepheids and RR Lyrae stars are considered in the third section. In the last section the latest results on nonlinear, nonperiodic, radial pulsations for Cepheids and RR Lyrae stars are given.

27023 Instability strip of the anomalous Cepheids in the Draco dwarf spheroidal galaxy. Deupree, R.G.; Hodson, S.W. (Theoretical Division, Los Alamos Scientific Laboratory, University of California). *Astrophys. J.;* **218**: No. 3, 654-658(15 Dec 1977).

The instability strip of the anomalous Cepheids is located, and the location verifies that the variables must be more massive than the RR Lyrae variables. It is found that the red edge of the Population II instability strip becomes bluer as the stellar mass increases, as does the blue edge. This indicates that our previous RR Lyrae color-width results are effectively independent of mass. The changes in the anomalous Cepheid instability strip indicated by a new opacity table, whose prime improvement is the inclusion of a number of molecules, and by the hypothesis that the helium abundance in the Draco system is slightly less than in the Galaxy, are examined.

QUASI-STELLAR, RADIO, AND X-RAY SOURCES

27024 (LA—7092-MS) **Fluctuations of quasars and other astronomical sources: final report on New Research Initiatives Program W-210.** Terrell, J. (Los Alamos Scientific Lab., N.Mex. (USA)). Jan 1978. Contract W-7405-ENG-36. 29p. Dep. NTIS, PC A03/MF A01.

New Research Initiatives Program W-210 produced a number of scientific results, publications, colloquia, and talks. Investigations under this program dealt with power spectra of fluctuating light sources, the apparent expansion rates of astronomical sources exploding at relativistic speed, the limits on fluctuation rates of such expanding (and nonexpanding) light sources, and related matters. Probably the most important result was a study of the time history of such an exploding light source, which showed that a widely held belief that unusually rapid fluctuations of light output would be produced in this case is not correct. This result has an important bearing on the interpretation of the redshifts of quasars and BL Lac objects, indicating that cosmological distance is very difficult to reconcile with the observations of rapid variations of luminosity. These results, and the power-spectrum results, are also of considerable interest in the study of astronomical x-ray sources. A list of publications is included.

SOLAR PHENOMENA

27025 (AD-A—043336) **Comparison of H-alpha synoptic charts with the large-scale solar magnetic field as observed at Stanford. Scientific technical report.** Duvall, T.L. Jr; Wilcox, J.M.; Svalgaard, L.; Scherrer, P.H.; McIntosh, P.S. (Stanford Univ., Calif. (USA). Inst. for Plasma Research). May 1977. Contract N00014-76-C-0207. 15p. (SU-IPR—700). NTIS PC A02/MF A01.

Two methods of observing the neutral line of the large-scale photospheric magnetic field are compared: (1) neutral line positions inferred from H-alpha photographs and (2) observations of the photospheric magnetic field made with low spatial resolution (3 arc min.) and high sensitivity using the Stanford magnetograph.

27026 (AD-A—043372) **Aerospace Corporation space sciences program: report to COSPAR CY 1976. Interim report.** Paulikas, G.A. (Aerospace Corp., El Segundo, Calif. (USA). Space Physics Lab.). 29 Jul 1977. Contracts F04701-76-C-0077;NAS8-29602. 13p. NTIS PC A02/MF A01.

This report reviews the results obtained by the space research program in solar physics, magnetospheric physics, and aeronomy and atmospheric science.

27027 (PB—273617) **Solar—geophysical data number 396, August 1977. Part I. (Prompt Reports). Data for July 1977—June 1977.** Coffey, H.E. (National Geophysical and Solar-Terrestrial Data Center, Boulder, Colo. (USA)). Aug 1977. 122p. (SGD—396-Pt-1). NTIS PC A06/MF A01.

This prompt report provides data for July 1977 on: alert periods, daily solar indices, solar flares, solar radio waves, solar x-ray radiation, coronal holes, spacecraft observations, solar wind measurements, inferred IP magnetic field polarities, and mean solar magnetic field. It also provides data for June 1977 on daily solar activity centers, sudden ionospheric disturbances, solar radio waves, cosmic rays, geomagnetic indices and radio propagation indices.

27028 (PB—273618) **Solar—geo/physical data number 396, August 1977. Part II (comprehensive reports). Data for February 1977—January 1977 and miscellanea.** Coffey, H.E. (National Geophysical and Solar-Terrestrial Data Center, Boulder, Colo. (USA)). Aug 1977. 48p. (SGD—396-Pt-2). NTIS PC A03/MF A01.

This comprehensive report for February 1977, January 1977 and Miscellaneous data provides data on active regions, synoptic solar maps, solar flares, solar radio waves, energetic solar particles and plasma, synoptic chart, abbreviated calendar record, regional flare index, solar radio waves for May 1977, and Cosmic rays for April 1977.

GALAXIES

27029 (TRITA-EPP—77-14) **Electric currents in cosmic plasmas.** Alfven, H. (SEE ALSO- 6140550 Kungliga Tekniska Hoegskolan, Stockholm (Sweden). Institutionen foer Plasmafysik). May 1977. 75p. Dep. NTIS (US Sales Only), PC A05/MF A01.

Since the beginning of the century physics has been dualistic in the sense that some phenomena are described by a field concept, others by a particle concept. This dualism is essential also in the physics of cosmical plasmas: some phenomena should be described by a magnetic field formalism, others by an electric current formalism. During the first period of evolution of cosmic plasma physics the magnetic field aspect has dominated, and a fairly exhaustive description has been given of those phenomena--like the propagation of waves--which can be described in this way. We have now entered a second period which is dominated by a systematic exploration of the particle (or current) aspect. A survey is given of a number of phenomena which can be understood only from the particle aspect. These include the formation of electric double layers, the origin of explosive events like magnetic substorms and solar flares, and further, the transfer of energy from one region to another. A useful method of exploring many of these phenomena is to draw the electric circuit in which the current flows and study its properties. A number of simple circuits are analyzed in this way.

27030 X-ray spectrum and structure of the Puppis a supernova remnant. Zarnecki, J.C.; Culhane, J.L.; Toor, A.; Seward, F.D.; Charles, P.A. (Mullard Space Science Laboratory, University College London). *Astrophys. J., Lett.;* **219**: No. 1, L17-L21(1 Jan 1978).

New observations have been made by the Ariel 5 satellite of the supernova remnant Puppis A in the energy range 1.5—6 keV. These findings are combined with previous soft X-ray data and crystal spectrometer results to show that the X-ray spectrum of Puppis A is characterized by a two-component model. Interpreted in terms of known X-ray line-emission spectra with standard cosmic abundances, the new data show that these two components have temperatures of 12.6 and 2.5 x 10^{20} cm^{-2}, a value which favors a lower source distance than previously assumed. Reanalysis of the Copernicus data shows that this cooler region, which is responsible for the O VIII line emission, is spatially coincident with the soft X-ray region recently delineated by others.

COSMOLOGY

REFER ALSO TO CITATION(S) 27146

ATMOSPHERIC PHYSICS

27031 Three velocity component, nonhomogeneous atmospheric boundary-layer turbulence modeling. Perlmutter, M. (Pittsburgh Energy Research Center); Frost, W.; Fichtl, G.H. *AIAA (Am. Inst. Aeronaut. Astronaut.) J.;* **15**: No. 10, 1444-1454(Oct 1977).

A new method of simulating the atmospheric turbulent winds by filtering Gaussian white noise signals and thereby generating signals that have the same second moment statistics as the atmospheric winds is presented. The governing equations are developed for the two-level autospectrum for the turbulent-wind components. A control system is modeled in which white Gaussian noise signals can be filtered, thereby generating signals with the same two level autospectra as the turbulent winds. An example calculation using the Dryden Autospectrum, an exponential coherence, and a linear phase angle is illustrated. The method is extended to include the two-level cross-spectrum between orthogonal components as well, and the appropriate filters are developed.

AURORAL AND IONOSPHERIC PHENOMENA

27032 (AD-A—042183) **Hiris experiment-Chatanika radar results. Topical report, January—December 1976.** Watt, T.M. (Stanford Research Inst., Menlo Park, Calif. (USA)). Jan 1977. Contract DNA001-77-C-0042. 34p. (SRI-TR—9). NTIS PC A03/MF A01.

Results of the Chatanika DNA 617 Radar support of the HIRIS rocket experiment are presented, along with magnetometer, riometer, and all-sky camera data to give a more complete picture of ionospheric processes. The HIRIS experiment took place on 1 April 1976, beginning at 0805:20 UT. The purpose of the experiment was to measure IR emissions in an aurorally disturbed ionosphere. The Chatanika radar was operated in support of the rocket experiment from 0626 UT to 0821 UT. Radar data acquired during the HIRIS experiment are presented in this report. Background electron densities in the vicinity of the rocket trajectory ranged between 30,000 and 300,000 cc. During the background measurement period (<0745 UT) the peak of the auroral-E layer appeared to be above the

trajectory apogee with electron densities at all altitudes fluctuating with time. Horizontal gradients in density were observed from about 0700 to 0730 UT and seemed consistent with a density enhancement moving geomagnetically west. During the elevation-scan measurements just prior to launch the peak of the ionization layer varied from 100 to 120 km and ionization density continued to fluctuate with time. Vector quantities measured during the prelaunch background period were indicative of the active conditions present during the experiment. Conductivities, current densities, neutral winds and electric fields all tended to be unipolar during the measurement period, but exhibited large peaks centered at about 0640 and 0730 UT.

27033 (AD-A—042185) **Investigation of ion-ion recombination cross sections. Scientific report No. 2 (annual) 19 October 1975—18 October 1976.** Smith, F.T.; Hickman, A.P. (Stanford Research Inst., Menlo Park, Calif. (USA). Molecular Physics Center). 18 Feb 1977. Contract F19628-75-C-0050. 30p. (SRI-MP—77-13; SR—21). NTIS PC A03/MF A01.

This is a brief review of the chief theoretical methods for estimating atomic and molecular collision processes for use in atmospheric and ionoshperic modelling. It is intended for inclusion in the DNA Reaction Rate Handbook. The principles of the most important techniques are mentioned, and reference made to more complete treatments. Problems include reactive and non-reactive collisions, energy transfer, ionization and neutralization. (Author)

27034 (AD-A—042261) **Data processing and analysis for icecap and related projects. Final scientific report, 4 December 1972—3 December 1976.** Delorey, D.E.; Pruneau, P.N. (Boston Coll., Chestnut Hill, Mass. (USA). Mass Space Data Analysis Lab.). 31 Jan 1977. Contract F19628-73-C-0133. 254p. (BC-SDAL—77-02). NTIS PC A12/MF A01.

This report summarizes the data processing techniques and procedures used in the creation of data bases for ICECAP, EXCEDE and related projects. The data processing system and management procedures are detailed. Data bases created are summarized. Calibration information used in parameter determinations is also summarized. (Author)

27035 (AD-A—042491) **EXCEDE II. Environmental research papers.** O'Neil, R.R.; Lee, E.T.P.; Stair, A.T. Jr; Ulwick, J.C. (Air Force Geophysics Lab., Hanscom AFB, Mass. (USA)). 21 Dec 1976. 38p. (AFGL-TR—76-0308; AFGL-ERP—586). NTIS PC A03/MF A01.

EXCEDE is a program designed to study atmospheric infrared emissive processes induced by a rocketborne electron accelerator in the altitude range 80 to 140 km. The primary scientific interest is the investigation of the detailed production and loss processes of various excited electronic and vibrational states resulting in optical and infrared emission as energetic primary electrons and their secondary and all subsequent generation electrons are stopped in the atmosphere. The electron-induced optical and infrared emissions simulate natural auroral processes with the very significant advantage that the dosing conditions of electron energy and power, deposition volume and altitude, and dosing duration are parameters that may be controlled and monitored. To date, three payloads have been launched in the EXCEDE series of artificial auroral experiments. The program status is reviewed and a follow on experiment, EXCEDE II, is described. Both rocket-based and ground-based imaging and spectro-radiometric instruments are proposed. The feasibility of the scientific approach, the magnitude of the atmospheric emissions, the capabilities of ground-support systems, and the engineering design of the proposed experiment are extensions of the technology base established in the earlier EXCEDE launches.

27036 (AD-A—042501) **Observations of electron temperature gradients in mid-latitude E sub S layers. Revision. Interim report.** Szuszczewicz, E.P.; Holmes, J.C. (Naval Research Lab., Washington, D.C. (USA)). Jun 1977. 42p. (NRL-MR—3345-Rev). NTIS PC A03/MF A01.

Using a newly-developed pulsed plasma probe, direct measurements of electron temperature were performed within mid-latitude sporadic-E layers above White Sands, New Mexico. The probe's capability for unfolding density variations from its current-voltage characteristic made the temperature measurements possible within the steep density gradients characteristic of E sub s layers. The major feature of the observations was the presence of an electron temperature gradient across the layers: the bottom-sides of the layers were isothermal at Te = 340 K while the topside of each layer showed Te increasing from 380 to more than 500 K over a vertical extent of 400 meters. The results are discussed in terms of reversible heating by gravity waves, as well as in terms of plasma density and ion composition effects within the ionospheric plasma itself. (Author)

27037 (AD-A—042687) **Energization of polar-cusp electrons at the noon meridian. Progress report.** Craven, J.D.; Frank, L.A. (Iowa Univ., Iowa City (USA). Dept. of Physics and Astronomy). Jul 1977. Contracts N00014-76-C-0016;NAS5-11265. 29p. NTIS PC A03/MF A01.

Observations gained with an electrostatic analyzer on board the low-altitude satellite Ariel 4 demonstrate that the directional, differential spectra of polar-cusp electron intensities are regulated by the sign of the elevation angle of the interplanetary magnetic field, theta(IMF). The altitude of the nearly circular, polar orbit was about 550 km. In the energy range $200 < E < 700$ eV, spectra of polar-cusp electron intensities were not observed to respond to changes in the sign of theta(IMF) . At greater energies, spectra were found to be significantly harder when theta(IMF) > 0 deg, with enhancements of a factor of about 10 typical for 2-keV electron intensities. Furthermore, these enhanced intensities appear to be localized within about a 1-hour sector of magnetic local time centered on the noon meridian. Enhanced intensities were detected during each sampling of electron intensities at local times MLT = 11.5 - 12.6 hours when theta(IMF) > 0 deg, but were observed only occasionally at lesser and greater local times. The physical processes responsible for the observed enhancements in electron intensities are of an unknown nature. Trapped magnetospheric electrons of sufficient intensities, which are generally present just equatorward of the polar cusp, are ruled out as a possible source.

27038 (AD-A—043666) **Ionospheric irregularities: optical support of HAES scintillation experiments. Final report, 15 December 1975—31 January 1977.** Sears, R.D. (Lockheed Missiles and Space Co., Palo Alto, Calif. (USA). Lockheed Palo Alto Research Lab.). 31 Jan 1977. Contract DNA001-76-C-0182. 85p. NTIS PC A05/MF A01.

Photometric measurements of auroral spectral emission features and of the horizontal phase velocity of auroral motions were conducted at Chatanika, Alaska, during several observing periods in 1976. These experiments provided ground-based optical support for the DNA HAES (High Altitude Effects Simulation) rocket experiments launched from Poker Flat. Multispectral data on the auroral emission intensities at 4278A and 6300A and the intensity ratio were analyzed in terms of the mean energy parameter for an assumed Maxwellian flux of precipitating electrons. Comparison between photometric determination of the mean energy parameter and that derived from incoherent scatter radar data provided a useful cross calibration of the two measurement techniques. This agreement also tends to confirm the theoretical predictions for the intensity ratio R sub 64 1(6300)/1(4278) as a function of the mean energy parameter. Additional analytical work was conducted to improve the three beam analysis code which allows inference of auroral E-fields and associated quantities from the auroral motion and intensity data. Results of the improved code are presented for the WIDEBAND rocket support experiment.

EFFECTS OF NUCLEAR DETONATIONS

27039 (AD-A—043546) **ROSCOE manual. Volume 16. High-altitude neutral-particle motion. Final report, 1 March 1974—31 January 1975.** Hamlin, D.A.; Smith, C.A.; Schoonover, M.R.; Wang, J.Y. (General Research Corp., Santa Barbara, Calif. (USA)). 8 Aug 1975. Contract DNA001-74-C-0182. 203p.

Two preliminary, alternative models of the high-altitude (h > or = 90 km) neutral-particle motion have been adopted for use in ROSCOE. Both models are one-dimensional spherical Lagrangian models and describe the vertical hydrodynamic motion in each geocentric column in an array of perhaps 100 such continuous but independent columns covering the disturbed region of interest. The models (SAIHYD, NRLHYD) describe the motion of a set of either Lagrangian cells or points by using the method of either difference equations or differential quadrature, respectively. Both models have automatic rezone capability. The geocentric columns defining the geometry for the calculations are described in terms of an arbitrarily positioned and oriented quadrupole coordinate system. Each Lagrangian cell or point is characterized by not only the hydrodynamic properties but also a set of chemistry quantities. The chemistry is loosely coupled to the hydrodynamics. Herein are presented details of the quadrupole coordinate system, the working form of the hydrodynamic equations and their initialization and methods for solution, the results of a test problem for a large-yield event at 200-km altitude producing motion in a linear array of six columns.

27040 (AD-A—043547) **ROSCOE manual. Volume 17. High-altitude debris-energy deposition. Final report, 1 March 1974—31 January 1975.** Hamlin, D.A.; Wang, J.Y.; Schoonover, M.R.; Valerio, J.I. (General Research Corp., Santa Barbara, Calif. (USA)). 22 Sep 1975. Contract DNA001-74-C-0182. 125p.

Models of the high-altitude debris-energy partition and deposition have been adopted for use in ROSCOE. The models for the debris-energy partition and heavy-particle source spectra incorporate the work of Crevier and Kilb for the loss-cone and ion-leak particles. The determination of the total (and spectrum of the) UV portion of the kinetic yield remaining after that assigned to all the

heavy-particle motion is based on the work of Fajen and Sappenfield. Representative points in the spatial distribution function specified for the loss-cone and ion-leak particles are used as effective source points through which magnetic field lines are traced in the downward direction through the intercepted grid cells in the geocentric quadrupole coordinate system. Conventional heavy-particle range-energy theory is employed along these paths, without regard to spiralling effects, to deposit the energy of these heavy particles in the traversed cells. Charge-exchange particles are deposited without regard to the magnetic field. The total heavy-particle energies deposited by inelastic and by elastic collisions in each cell are partitioned into various modes and species which are ultimately made compatible with the late-time grid chemistry. The UV energy groups, as well as the x-ray energy, are deposited by tracing ray paths (and constructing line integrals of relevant species) from the event point to each cell in the high-altitude grid treated as a target cell.

27041 (AD-A—043873) **Project STRESS satellite communication test results. Final technical report, June 1976—March 1977.** Prettie, C.; Johnson, A.; Marshall, J.; Grizinski, T.; Swanson, R. (Air Force Avionics Lab., Wright-Patterson AFB, Ohio (USA)). Jul 1977. 124p. (AFAL-TR—77-158).

In order to evaluate the effects of a nuclear disturbance of the ionosphere on UHF satellite communication, barium ions were released in the ionosphere. The test, nicknamed STRESS, was sponsored by the Defense Nuclear Agency. The drift of the barium ions across the magnetic field lines cause the ions to consolidate in rods, or sheets, causing diffraction of radio waves passing through the ionosphere. AFAL's Satellite Communication System aboard a C-135 type aircraft was flown in the shadow of the cloud and communicated through the ionospheric disturbance to the LES 8/9 UHF satellites. Measurements were made of the fading characteristics and bit error rate performance when communicating through the ionospheric disturbance. (Author)

27042 (AD-A—046092) **Energy deposition rates and Compton electron currents from low-altitude bursts as a function of source energy. Interim report 17 Nov 76—1 Nov 77.** Schechter, H.S.; Cohen, M.O. (Mathematical Applications Group, Inc., Elmsford, N.Y. (USA)). Sep 1977. Contract DAAG39-77-C-0020. 64p. (MR—7054). NTIS PC A04/MF A01.

A series of time-dependent Monte Carlo calculations has been performed to determine, as functions of neutron source energy band, the energy deposition rates and Compton electron sources in the air due to neutron and secondary photon interactions from weapons at 1-, 50-, 100-, and 200-m heights of burst. The calculations were made with a modified version of the SAM-CE computer program. The energy deposition rates and Compton electron sources were determined as functions of time (out to 100-ms local time), in 49 radial and altitude scoring bins surrounding the four isotropic point sources. Answers were obtained for penetrations from 0 to 2.4 km in the horizontal direction and from 0 to 1.5 km above the air-ground interface. The raw data have been forwarded to HDL for smoothing and curve fitting. Sample results are presented and described in this report.

27043 (AD-A—046237) **Effect of a cylindrically-symmetric ionospheric disturbance on elf propagation in the earth-ionosphere waveguide. Topical report.** Greifinger, C.; Greifinger, P. (R and D Associates, Santa Monica, Calif. (USA)). 10 Jun 1977. Contract DNA001-76-C-0001. 39p. (RDA-TR—2005-002). NTIS PC A03/MF A01.

A nuclear explosion in the earth's ionosphere produces a depression in the ionosphere that is approximately cylindrically symmetric. In this paper, a method is developed for calculating the change in amplitude and phase at a receiver of an ELF (extremely low frequency) radio wave in the presence of such a localized, cylindrically-symmetric disturbance. Numerical results are obtained for the particular configuration where the center of the disturbance is directly above the transmitter-receiver path. The attenuation from one edge of the disturbance to the opposite edge is found to be only about half of that calculated by the two-dimensional WKB approximation usually employed in such problems.

27044 (LA-UR—77-2835) **Characteristics of late-time striations observed during operation stress.** Wolcott, J.H.; Simons, D.J.; Eastman, T.E.; Fitzgerald, T.J. (Los Alamos Scientific Lab., N.Mex. (USA)). 1978. Contract W-7405-ENG-26. 14p. (CONF-780106—2). Dep. NTIS, PC A02/MF A01.

From Ionospheric effects symposium; Washington, DC, USA (24 Jan 1978).

Some results are presented on an experiment in progress of data analysis for a study of the actual satellite communication links through structured barium plasma clouds intended to simulate many aspects of the highly disturbed, post-nuclear-explosion upper atmosphere and the investigation of the late time spatial decay of plasma striations, or filamcnts, imbedded within the barium ion cloud. (JFP)

MAGNETOSPHERIC PHENOMENA

27045 (RLO/2229/T5—7) **Study of the magnetic field annihilation process in the magnetosphere and some applications (electric currents in the Trans-Alaska pipeline induced by auroral activity).** Akasofu, S.I. (Alaska Univ., Fairbanks (USA). Geophysical Inst.). May 1977. Contract EY-76-S-06-2229-005. 13p. NTIS, MF A01.

Portions of document are illegible.

Objectives of the project and some conclusions drawn from the work carried out so far are presented. 5 figures. (RWR)

ATOMIC, MOLECULAR, AND CHEMICAL PHYSICS

REFER ALSO TO CITATION(S) 27312

27046 Multiphoton dissociation products from halogenated hydrocarbons. Sudbo, A.S.; Schulz, P.A.; Grant, E.R.; Shen, Y.R.; Lee, Y.T. (Materials and Molecular Research Division, Lawrence Berkeley Laboratory, University of California, Berkeley, California 94720). *J. Chem. Phys.;* **68**: No. 3, 1306-1307(1 Feb 1978).

Multiphoton dissociation of various halogenated hydrocarbons by laser beams is reported. The statistical theory of unimolecular reactive is found to be adequate to explain the process.(AIP)

27047 Is multiphoton dissociation of molecules a statistical thermal process. Grant, E.R.; Schulz, P.A.; Sudbo, A.S.; Shen, Y.R.; Lee, Y.T. (Materials and Molecular Research Division, Lawrence Berkeley Laboratory, University of California, Berkeley, California 94720). *Phys. Rev. Lett.;* **40**: No. 2, 115-118(9 Jan 1978).

We present here a phenomenological model calculation that exhibits the realistic qualitative behavior of multiphonon excitation and dissociation of polyatomic molecules. It is also used to show that at least theoretically multiphonon excitation of molecules is not equivalent to thermal heating.

27048 Atomic diamagnetism and diamagnetically induced configuration mixing in laser-excited barium. Fonck, R.J.; Roesler, F.L.; Tracy, D.H.; Lu, K.T.; Tomkins, F.S.; Garton, W.R.S. (Physics Department, University of Wisconsin, Madison, Wisconsin 53706). *Phys. Rev. Lett.;* **39**: No. 24, 1513-1516(12 Dec 1977).

The diamagnetic Zeeman effect has been isolated by observing energy shifts of the 6s6p $^1P_1{}^o$-6sns $^1S_0$ Rydberg series in laser-excited Ba in magnetic fields of 20—40 kG. Perturbation of this series by the 5d7d $^1S_0$ level reduces the shift below the hydrogenic value for n = 18. Magnetically induced mixing between the 6sns $^1S_0$ and 6snd $^1D_2$ series causes both an enhancement in intensity of the higher members of the $^1S_0$ series and deviations of the shifts from the hydrogenic values.

27049 Configuration-interaction effects on the L and M Auger spectra of Cu and Zn. McGuire, E.J. (Sandia Laboratories, Albuquerque, New Mexico 87115). *Phys. Rev., A;* **16**: No. 6, 2365-2375(Dec 1977).

Configuration interaction (CI) effects are examined for both initial and final states in the L- and M-shell Auger spectra of Cu and Zn. CI accounts for the anomalous energy splitting of ^1D and ^3P terms in the L/sub 2,3/-M/sub 2,3/M/sub 2,3/ Auger transition. At the same time CI increases the L/sub 2,3/-M/sub 2,3/M/sub 2,3/ ^1D transitions rate, so that the ^1D intensity is comparable to the ^3D intensity. CI effects on the ^1D double-vancancy lifetimes, while in the right direction, are not sufficient to account for the observed difference in L_3-M_1,M/sub 4,5/ ^1D and ^3D linewidths. CI effects cannot account for the discrepancy between calculated and measured M_1 and M/sub 2,3/ linewidths. It is hypothesized that the discrepancy arises from the use of Herman-Skillman rather than Hartree-Fock wave functions in the calculation of low-energy super Coster-Kronig matrix elements. With matrix elements adjusted via this hypothesis the M_1-VV and M/sub 2,3/-VV Auger line shapes are calculated for Cu. Further the L_3-M/sub 2/3/M/sub 2,3/ and L_3-M/sub 2,3/M/sub 4,5/ lineshapes, including final state lifetime effects, are calculated. The latter calculations indicate that a discrepancy between calculated and measured L/sub 2,3/-MM configuration intensities is an experimental artifact.

27050 Theoretical study of the photoionization of metastable neon. Hazi, A.U.; Rescigno, T.N. (Theoretical Atomic and Molecular Physics Group, University of California, Lawrence Livermore Laboratory, P. O. Box 808, Livermore, California 94550). *Phys. Rev., A;* **16**: No. 6, 2376-2387(Dec 1977).

We have calculated the photoionization cross section for the $(1s^22s^22p^53s)^3P$ metastable state of neon using ab initio, many-electron wave functions in the LS-coupling scheme. We have considered all the channels which arise from the $(1s^22s^22p^5)^2P$ state of Ne^+ and an ejected p electron. The continuum was made discrete by approximating the final states as superpositions of square-integrable configurations. The Stieltjes moment-theory technique was used to

construct the continuum oscillator strength distribution. Both the dipole-length and the dipole-velocity forms of the cross section were evaluated. We have examined systematically the effects of orbital relaxation, core polarization, and electron correlation and found them to be important within 5 eV of threshold. The peak value of the photoionization cross section for metastable Ne is 1.9 x 10^{-19} cm^2, which is much smaller than the corresponding value for the ground state. We have also calculated the line strengths for a few bound-bound transitions as well as the static polarizability of the ^3P metastable state.

27051 Multiphoton absorption in the presence of two finite-bandwidth lasers. Wong, N.C.; Eberly, J.H. (Department of Physics and Astronomy, University of Rochester, Rochester, New York 14627). *Opt. Lett.;* **1**: No. 6, 211-213(Dec 1977).

Interactions between a three-level atom and two amplitude-fluctuating lasers are studied theoretically. One interesting feature of the interactions is the influence of the finite laser bandwidth and the two-laser cross-bandwith on the absorption rate into the third level. As an example, it is shown how the partially saturated absorption process depends on both the autocorrelated and cross-correlated laser bandwidths.

27052 Rotational-vibrational transition moments in excited states of spherical-top molecules. Fox, K. (Department of Physics and Astronomy, University of Tennessee, Knoxville, Tennessee 37916). *Opt. Lett.;* **1**: No. 6, 214-216(Dec 1977).

Selection rules and electric-dipole transition moments between rotational substates in excited vibrational states of spherical-top molecules have been derived. The explicit dependence of these moments on rotational and vibrational quantum numbers has been calculated. These results, which are generally applicable, have been used to analyze the concept of a multiple-photon pathway in the ν_3 "ladder" of SF_6. It will be shown that some ladder schemes must have "rung gaps" in their sequence of proposed strongly allowed electric-dipole transitions.

27053 Ordering of the excited-state energy levels of various atoms and their isoelectronic ions. II. Sternheimer, R.M. (Brookhaven National Laboratory, Upton, New York 11973). *Phys. Rev., A;* **16**: No. 5, 1752-1759(Nov 1977).

In two previous papers, the quantum number k equivalent n + l was considered as an energy-ordering quantum number for the excited states of 42 atoms and ions, which can be regarded as being composed of a single excited valence electron outside closed shells. It was shown that the energy levels of the valence electron are energy ordered according to the (increasing) values of k, and moreover within each k group or k band, there is a definite and generally constant sequence of l values for each atom or ion, as the electronic energy is increased within the k band; this sequence has been called the "l pattern." Altogether 42 spectra involving 1155 levels were included in the previous investigation. Of these 1155 levels, 120 show a small deviation from k ordering, and these have been called "k + λ exceptions." In the present work, a thorough analysis of these k + λ exception has been made, and it has been found that in the vast majority of the cases, the k + λ exceptions arise from the fact that the angular momentum l is too large, and is close to or larger than the limiting angular momentum l_1 for which a "phase transition" occurs from k ordering to hydrogenic (H) ordering, which is similar to the phase transition which arises when the ionicity δ equivalent Z - N (N being the number of electrons) is too large, and exceeds the "limiting ionicity" δ_1. A diagram showing the regions of validity of k and H ordering as a function of the angular momentum l and the atomic number Z, i.e., the curve of l_1 vs Z, has been obtained. A tentative explanation of the phase diagrams of δ vs Z and l vs Z is discussed, i.e., the reason why too large a value of δ or l will destroy the k ordering phase of the spectrum.

27054 Calculation of parity-nonconserving effects in forbidden M1 transitions in cesium. Neuffer, D.V.; Commins, E.D. (Physics Department, University of California, Berkeley, California, 94720). *Phys. Rev., A;* **16**: No. 5, 1760-1767(Nov 1977).

Calculations are presented of the E1 amplitude expected in forbidden M1 transitions of Cs if parity conservation is violated in the neutral weak e-N interaction, as proposed in a number of gauge models, including that of Weinberg and Salam. Valence electron wave functions are generated as numerical solutions of the Dirac equation in a Tietz central potential, and are used to calculate excited-state lifetimes, hfs splittings, and Stark E1 transition amplitudes. These are compared with experiment and are in good agreement. Contributions to the 6 ^{2}S/sub 1/2/-7 ^{2}S/sub 1/2/ and 6 ^{2}S/sub 1/2/-8 ^{2}S/sub 1/2/ transitions from relativistic effects, Breit interaction, interconfiguration interaction, and hfs mixing are calculated, and it is found that this theoretical description is not entirely adequate. The parity-nonconserving E1 amplitude E/sub PN/ for the 6 ^{2}S/sub 1/2/-7 ^{2}S/sub 1/2/ and 6 ^{2}S/sub 1/2/-8 ^{2}S/sub 1/2/ transitions is evaluated. The results E/sub PN/(6S-7S) = i3.50 x 10^{-11} Q/sub W/ vertical-bar μ/sub B/ vertical-bar and E/sub PN/(6S-8S) = i1.48 x 10^{-11}Q/sub W/ vertical-bar μ/sub B/ vertical-bar are obtained. With a measured value of the M1 amplitude M/sub expt/ and the Weinberg value Q/sub W/ = -99, we find a circular dichroism δ = 1.64 x 10^{-4} for the 6 ^{2}S/sub 1/2/-7 ^{2}S/sub 1/2/ transition.

BEAMS AND THEIR REACTIONS

27055 (COO—3158-55) **Novel Faraday cup for the simultaneous observation and measurement of ion-beam currents.** Wei, C.Y.; Seidman, D.N. (Cornell Univ., Ithaca, N.Y. (USA)). Jul 1977. Contract EY-76-S-02-3158. 15p. Dep. NTIS, PC A02/MF A01.

The Faraday cup is constructed around a Galileo channel electron multiplier array (CEMA) which serves as the basis of an internal image intensification system (a gain of greater than 10^4) for the observation of the ion beam; the CEMA also acts as a collector for the ion cured by a Keithley 602 electrometer. The ion current is integrated by a simple and inexpensive dosimeter; the electronic circuit for the dosimeter is described. The application of the Faraday cup to the observation and measurement of a 30 keV Ar^+ ion beam is presented as an illustrative example. This Faraday cup was also employed to observe and measure 30 keV Cr^+, Mo^+ or W^+ and 18 keV Au^+ ion beams employed for the in-situ irradiation of field-ion microscope specimens.

ATOMIC AND MOLECULAR PROPERTIES

27056 (AD-A—042228) **L shell fluorescence yields and Coster-Kronig transition probabilities using radioactive sources. Final report.** Palms, J.M.; Rao, P.V.; Wood, R.E. (General Electric Co., Idaho Falls, Idaho (USA). Flight Propulsion Lab. Dept.). 1 Jan 1975. 10p. NTIS PC A02/MF A01.

Accurate knowledge of x-ray fluorescence yields is an important ingredient in the solution of many practical problems and in the understanding of the decay mechanisms of atomic states characterized by inner-shell vacancies. In the present work, coincidence and singles techniques, employing high resolution semiconductor x-ray detectors and radioactive isotopes, are applied to obtain information on the decay of inner-shell vacancy atomic states. Precision measurements of K-shell fluorescence yields at Z = 78, 82 and 92 are performed. X ray and Coster-Kronig yields at Z > 60 are measured. It is clearly established that a discrepancy exists in the interpretation of experimentally observed L2 subshell Coster-Kronig transition probability around Z = 80. A careful and detailed study of the decay of (LL)-, (LX)-vacancy atomic states at Z = 82 (in the decay of 207 Bi) is made by (x-ray)-(x-ray) and (x-ray) Auger electron coincidence techniques.

27057 (BNL—23394) **Dependence of anti W on the charge of heavy ions.** Varma, M.N.; Baum, J.J. (Brookhaven National Lab., Upton, N.Y. (USA)). Oct 1977. Contract EY-76-C-02-0016. 6p. (CONF-771209—2). Dep. NTIS, PC A02/MF A01.

From IAEA symposium on national and international standardization of radiation dosimetry; Atlanta, GA, USA (5 Dec 1977).

Anti W values (average energy required to form an ion pair) were determined for ^{35}Cl ions in nitrogen and tissue-equivalent gas. These values were compared to previously reported anti W values for oxygen ions and alpha particles in the same media. This comparison was made at two specific values of energy per atomic mass unit of the incident ions. At an energy of 2.57 MeV/amu, the comparison shows anti W is 12% and 10% higher for oxygen ions in tissue-equivalent and nitrogen gas, respectively, relative to alpha particle anti W. At an energy of 0.77 MeV/amu, a similar comparison shows anti W is 20% higher for ^{35}Cl ions and 12% higher for ^{16}O ions in tissue-equivalent gas; and 13% and 10% higher, respectively, in nitrogen gas, relative to alpha particle anti W. These results indicate that anti W values depend not only on the energy per atomic mass unit of heavy ions but also on their charge.

27058 Effect of an electric field upon resonances in the H^- ion. Gram, P.A.M.; Pratt, J.C.; Yates-Williams, M.A.; Bryant, H.C.; Donahue, J.; Sharifian, H.; Tootoonchi, H. (Los Alamos Scientific Laboratory, Los Alamos, New Mexico 87545). *Phys. Rev. Lett.;* **40**: No. 2, 107-111(9 Jan 1978).

Two resonances in the photodetachment cross section of H^- have been studied in a variable dc electric field by exploiting a relativistic colliding-beam technique. The Feshbach resonance, at a photon energy of 10.930 eV, splits into two and, possibly, a smaller third component for field strengths of about 10^5 V/cm, disappearing entirely for fields greater than 2 x 10^5 V/cm. The shape resonance, at a photon energy of 10.98 eV, begins to diminish in amplitude and broaden only for fields above 5 x 10^5 V/cm.

27059 (LA-tr—78-1) **Experimental study of the optical absorption cross sections of nitrogen dioxide.** Plastinin, Yu.A. 1978. Translation of USSR report. 12p. Dep. NTIS, PC A02/MF A01.

Absorption spectra are discussed which come from a study of the radiation emitted from nitrogen dioxide heated to T equal to or greater than 2000°K. 16 references. (JFP)

27060 Experimental determination of the angular distribution of transition radiation following photoeffect. Grader, R.J.; Oliver, A.J.; Ebert, P.J. (University of California, Lawrence Livermore Laboratory, Livermore, California 94550). *Phys. Rev., A;* **16**: No. 6, 2388-2391(Dec 1977).

Theoretical considerations led to the prediction that the transition radiation following inner-shell photoionization has an angular dependence $I(\theta) \sim 1 + \beta P_2(\cos\theta)$. The asymmetry parameter β was determined experimentally for the L-III transitions (Ll and Lα) of uranium. A comparison with the calculations of Scofield indicates that the measured asymmetry (Ll = 0.062) is 40% greater than predicted. Our experiment was not sensitive enough to detect asymmetry in the Lα radiation.

27061 High-lying levels in uranium atomic vapor near the ionization limit. Lu, K.T. (Chemistry Division, Argonne National Laboratory, Argonne, Illinois 60439). *Phys. Rev., A;* **16**: No. 5, 2184-2186(Nov 1977).

This paper comments on the recent observation of Rydberg "progressions" in atomic uranium. A multichannel quantum-defect analysis shows that the observed ion peaks are unresolved groups of levels with different total angular momenta J and approximately the same effective quantum number ν/sub l n/, and configuration interactions are apparent. The possible number of channels and their assignment are outlined.

27062 Selective single atom detection in a 10^{19} atom background. Hurst, G.S.; Nayfeh, M.H.; Young, J.P.; Payne, M.G.; Grossman, L.W. (Oak Ridge National Lab., TN). pp 44-55 of Springer series in optical sciences. Vol. 7. Laser spectroscopy III. Hall, J.L.; Carlsten, J.L. (eds.). New York; Springer-Verlag (1977).

A recent energy pathways model for the de-excitation of excited helium gas [Payne et al., J. Chem. Phys. 63, 1422 (1975)] suggested that a key step $He(2^1P) + He(1^1S)$ yields $He(2^1S) + He(1^1S)$ had an unusually large cross section. This led to the need to measure the population of $He(2^1S)$ as a function of time following charged-particle excitation of $He(2^1P)$. The principle of resonance ionization spectroscopy is explained, and the ratio of $He(2^1S)$ to direct ionization is shown as a function of laser energy per pulse. Conditions for resonance ionization of atoms in their ground states are described; studies were made of two-photon ionization of Cs—Ar mixtures with the broadened Cs(7p) as an intermediate state. The topic of photodissociation of molecules: time-resolved sources of free atoms are discussed; all of the CsI molecules in the central portion of a laser beam could be dissociated to neutral Cs and I atoms in their ground states. The method is well suited to rather direct measurements of the diffusion of a small number of alkali atoms in various gases and to a remarkably simple determination of the rate of reaction of free atoms with various other atoms or molecules. One-atom detection of Cs in a background of 10^{19} atoms of Ar was demonstrated with a proportional counter. 12 figs. (RWR)

POSITRONIUM, MUONIUM, AND MUONIC AND MESIC ATOMS AND MOLECULES

27063 Breakup of relativistic positronium in the field of an atom. Dul'yan, L.S.; Kotsinyan, A.M.; Faustov, R.N. (Joint Institute for Nuclear Research). *Sov. J. Nucl. Phys. (Engl. Transl.);* **25**: No. 4, 434-437(Apr 1977).

The problem of breakup of relativistic positronium by an external field is considered in the impulse approximation. The cross section is calculated with relativistic wave functions of a bound system of two particles and a Thomas-Fermi atomic potential. It is shown that the cross section depends on the projection of the positronium spin on its momentum. The dependence of the cross section on atomic number is obtained for the ground state and also for excited S states.

COLLISION PHENOMENA

REFER ALSO TO CITATION(S) 27033

27064 (CALT—767P4-161) Technical progress report, 1 July 1976—30 November 1977. Kuppermann, A. (California Inst. of Tech., Pasadena (USA)). 1 Dec 1977. Contract EY-76-S-03-0767-004. 23p. Dep. NTIS, PC A02/MF A01.

Research on low energy electron scattering, variable-angle photoelectron spectroscopy, laser photochemistry and spectroscopy, collisions in crossed molecular beams, and energy relevance of research performed is described. A list of publications is included. 13 references. (JFP)

27065 Energy transfer cross sections in relation to generalized oscillator strengths for the donor—acceptor pair benzene—acetone. Klump, K.N.; Lassettre, E.N. (Department of Chemistry, Carnegie-Mellon University, Pittsburgh, Pennsylvania 15213). *J. Chem. Phys.;* **68**: No. 3, 886-895(1 Feb 1978).

Generalized oscillator strengths have been determined for the A ^{1}B/sub 2u/←X ^{1}A/sub 1g/ transition in benzene and the A $^1A_2$←X $^1A_1$ transition in acetone. From the data, and the spectroscopic data and analysis of the work of other investigators, the generalized oscillator strengths for the reverse transition in benzene have been calculated approximately. Huo's theory of energy transfer cross sections [J. Chem. Phys. 66, 3572 (1977)] and the generalized oscillator strengths have been used to calculate the cross section for the resonant energy transfer process benzene (A ^{1}B/sub 2u/) + acetone (X $^1A_1$) → benzene (X ^{1}A/sub 1g/)+acetone (A $^1A_2$). The energy transfer cross section calculated in this way is found to be 39 A^2 with an estimated uncertainty of +- 5 A^2. The experimental value is 33 +- 2 A^2 [K. Janda and F. S. Wettack, J. Am. Chem. Soc. 94, 305 (1972)]. Huo's theory is based on the Born approximation, neglecting electron exchange. The agreement between calculated and observed cross sections shows that the Born approximation (without exchange) is holding even though the molecules are colliding with relative velocities in the thermal range.

27066 Ionizing collisions of cesium and potassium atoms with water. Warmack, R.J.; Stockdale, J.A.D.; Compton, R.N. (Health and Safety Research Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830). *J. Chem. Phys.;* **68**: No. 3, 916-925(1 Feb 1978).

Crossed beam studies of K and Cs collisions with H_2O and D_2O have been made for laboratory alkali beam energies from 10 to 200 eV. The only ionic products observed were K^+, Cs^+, OH^-, and OD^-. The positive and negative ion thresholds are equal to within ~0.1 eV and correspond to the $H(^2S)+OH^-(^1\Sigma)$ limit of H_2O^-. The positive and negative ion energy and angular distributions are discussed including the observation of an OD^- "pickup" reaction.

27067 Design of natural collision coordinates to describe dissociation of polyatomic molecules. Band, Y.B.; Freed, K.F. (Argonne National Laboratory, Argonne, Illinois 60439). *J. Chem. Phys.;* **68**: No. 3, 1292-1302(1 Feb 1978).

We introduce a set of conditions to be satisfied by natural collision coordinates in order to enable the nonseparable multidimensional bound-continuum Franck—Condon integrals, arising in the quantum theory of collinear polyatomic dissociation processes, to be reduced to one-dimensional integrals. Because these conditions are not satisfied by available natural collision coordinate schemes, we investigate, in detail, the nature of one set of coordinates which satisfies these conditions. It is demonstrated that these coordinates can be chosen to faithfully represent the asymptotic motions of the fragments as well as the motion of the fragments in the Franck—Condon region on the repulsive electronic surface. The kinetic energy operator is displayed as an explicit function of the repulsive surface coordinates. The half-collision boundary conditions are described in a fashion to enable numerical computations of the continuum functions along the reaction coordinate.

27068 Collisions of H^- ions and fast H^0 atoms in a Cs vapor target. Girnius, R.J.; Anderson, C.J.; Anderson, L.W. (Department of Physics, University of Wisconsin, Madison, Wisconsin 53706). *Phys. Rev., A;* **16**: No. 6, 2225-2231(Dec 1977).

The charge-changing cross sections σ/sub -/0 and σ/sub -x/ σ/sub -/+ have been measured for H^- ions incident on a Cs vapor target with energies in the range 30—200 keV. When the incident ion has an energy of 100 keV, σ/sub -/0 = 1.80 x 10^{-15} cm^2 and σ/sub -/+ = 1.30 x 10^{-16} cm^2. The cross sections σ/sub g/ and σ/sub g/ have been measured for fast H(1s) atoms incident on a Cs target with energies in the range 30—200 keV. When the incident atom has an energy of 100 keV, σ/sub g/ = 5.58 x 10^{-16} cm^2 and σ/sub g/ = 3.75 x 10^{-18} cm^2. Also measured are the equilibrium fractions and the maximum neutral fraction when H^- is incident on a Cs vapor target with energy in the range 30—200 keV. The maximum neutral fraction when H^- is incident on Cs is 0.58 for energies in the range 100—200 keV.

27069 Nonresonant and resonant electron distributions from fast particle collisions: Application to sodium. Theodosiou, C.E. (Department of Physics, University of Chicago, Chicago, Illinois 60637). *Phys. Rev., A;* **16**: No. 6, 2232-2247(Dec 1977).

I present a general treatment for evaluating the angular distribution of ejected electrons from doublet resonant states and their interference with direct ionization. The formulation is applied to sodium, and the results are found to agree very well with two sets of experimental data. It is also found that the direct ionization cross section for sodium is unusually low for secondaries of ~25 eV, with a sharp peak at the angle predicted by the binary encounter approximation. The dependence of the incident and the secondary energies and other features of the process are discussed in detail.

27070 K-shell capture by protons from O_2, N_2, and Ne. Cocke, C.L.; Gardner, R.K.; Curnutte, B.; Bratton, T.; Saylor, T.K. (Kansas State University, Manhattan, Kansas 66506). *Phys. Rev., A;* **16**: No. 6, 2248-2255(Dec 1977).

We have measured the ratio of the cross section for K-electron capture to that for total K-vacancy production for 0.75—5-MeV protons on targets of O_2, N_2, and Ne. This was done by detecting Auger electrons from the target K-shell relaxation in coincidence with charge-neutralized projectiles. The fraction of K-shell vacancy production due to electron capture ranges from 0.028% to 3.3%, and the K-shell fraction of total electron capture from 2.5% to over 80%. By combining these data with previously measured (or calculated) cross sections for total K-vacancy production, we deduce cross sections for K-shell capture alone. The cross sections follow Oppenheimer-Brinkman-Kramers scaling laws for higher velocities, and are in fair absolute agreement with more complete charge-transfer calculations.

27071 Rotational resonances in low-energy electron scattering by H_2 and D_2. Garrett, W.R. (Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830). *Phys. Rev., A;* **16**: No. 6, 2305-2314(Dec 1977).

The conditions necessary to sustain rotational resonances in very low-energy electron scattering by molecular hydrogen are examined. Semiempirical interaction potentials are used in close-coupling calculations to obtain resonance energies, as eigenvalues of a projected Hamiltonian, and phase shifts and resonance widths from solutions for the total Hamiltonian. An unrealistic electron-molecule interaction potential is required in order to sustain a rotational resonance under single collision conditions. However, at high densities where average molecular separations are of the order of $15a_0$ to $30a_0$, resonance structure can be generated through a model potential which includes a modification due to neighboring molecules. Effects due to the presence of molecular dimers are also investigated.

27072 Continuum orbital approximations in weak-coupling theories for inelastic electron scattering. Peek, J.M.; Mann, J.B. (Sandia Laboratories, Albuquerque, New Mexico 87115). *Phys. Rev., A;* **16**: No. 6, 2315-2322(Dec 1977).

Two approximations, motivated by heavy-particle scattering theory, are tested for weak-coupling electron-atom (ion) inelastic scattering theory. They consist of replacing the one-electron scattering orbitals by their Langer uniform approximations and the use of an average trajectory approximation which entirely avoids the necessity for generating continuum orbitals. Numerical tests for a dipole-allowed and a dipole-forbidden event, based on Coulomb-Born theory with exchange neglected, reveal the error trends. It is concluded that the uniform approximation gives a satisfactory prediction for traditional weak-coupling theories while the average approximation should be limited to collision energies exceeding at least twice the threshold energy. The accuracy for both approximations is higher for positive ions than for neutral targets. Partial-wave collision-strength data indicate that greater care should be exercised in using these approximations to predict quantities differential in the scattering angle. An application to the 2s ^{2}S-2p ^{2}P transition in Ne VIII is presented.

27073 Comments on the existence of low-energy d-wave resonances in electron-fluorine atom scattering. Rescigno, T.N.; Hazi, A.U.; Winter, N. (Theoretical Atomic and Molecular Physics Group, University of California, Lawrence Livermore Laboratory, P. O. Box 808, Livermore, California 94550). *Phys. Rev., A;* **16**: No. 6, 2488-2490(Dec 1977).

It is argued that the very narrow, low-energy ^{1}D/sup o/ and ^{1}P/sup o/ d-wave shape resonances in the e^--F system reported by Ormonde must be artifacts. Evidence that this is so is drawn from numerical Hartree-Fock calculations, from construction of effective local potentials, from calculations with model polarization potentials, and from extensive configuration-interaction/stabilization computations. No evidence of such resonance behavior is found in any of these calculations.

27074 Close-coupling calculations of electron scattering by atomic fluorine. Robb, W.D.; Henry, R.J.W. (Theoretical Division (Group T-4), Los Alamos Scientific Laboratory, Los Alamos, New Mexico 87545). *Phys. Rev., A;* **16**: No. 6, 2491-2492(Dec 1977).

The close-coupling (CC) calculations reported by Ormonde for e^- + F scattering have been repeated using independent CC computer programs. No evidence of very narrow, low-energy shape resonances is observed in the ^{1}P/sup o/ and ^{1}D/sup o/ d waves.

27075 Alignment of helium excited by thin carbon foils. Hight, R.D.; Schectman, R.M.; Berry, H.G.; Gabrielse, G.; Gay, T. (Department of Physics and Astronomy, University of Toledo, Toledo, Ohio 43606). *Phys. Rev., A;* **16**: No. 5, 1805-1810(Nov 1977).

We have measured the linear polarization of the 5016-A, 2s ^{1}S-3p ^{1}P transition of He I excited by a thin carbon foil perpendicular to the incident He^+ beam at ion energies 50—500 keV. We find that the alignment of the 3p ^{1}P term depends upon the beam current density within the range (2—150 $\mu A\ cm^{-2}$) measured. Oscillations in the dependence of both M/I (the linear polarization fraction) upon energy and the current density variation of M/I with energy are observed. We discuss possible origins of these variations.

27076 Electron loss by atomic and molecular hydrogen in collisions with $^3He^{++}$ and $^4He^+$. Olson, R.E.; Salop, A.; Phaneuf, R.A.; Meyer, F.W. (Stanford Research Institute, Menlo Park, California 94025). *Phys. Rev., A;* **16**: No. 5, 1867-1872(Nov 1977).

Total cross sections for single-electron capture by $^4He^+$ and $^4He^{++}$ incident on atomic and molecular hydrogen have been measured in the velocity range (1—6) x 10^8 cm/sec. A classical-trajectory Monte Carlo method was also used to calculate the electron-capture and impact-ionization cross sections for He^{++} on H in this velocity range. The theoretical electron-capture cross sections are found to be in good agreement with the present experimental values at velocities above 2.5 x 10^8 cm/sec, but tend to underestimate the experimental values by roughly 25% at the lowest velocities. The experimental He^{++} + H electron-capture cross sections are in excellent agreement with the measurements of Shah and Gilbody in the velocity region where the two experiments overlap. No significant isotope effect ($^4He^{++}$ versus $^3He^{++}$) could be discerned on the theoretical cross sections as a function of relative velocity.

27077 Role of K-shell vacancies in determining charge-state fractions for heavy ions emerging from solids. Gray, T.J.; Cocke, C.L.; Gardner, R.K. (Department of Physics, Kansas State University, Manhattan, Kansas 66506). *Phys. Rev., A;* **16**: No. 5, 1907-1914(Nov 1977).

The development of projectile K vacancies in heavy ions passing through solids has recently been studied using both target and projectile x-ray yields. The analysis of these results implies that the post-foil charge-state fractions will exhibit a target thickness dependence which is related to the vacancy production and quenching processes for the K shell of the projectile as it moves in the solid. We report experimental results for the charge-state fractions of 54-MeV S ions on thin foils of C, Al, Ti, and Ni. We propose a model which accounts for both the target thickness and the target-atomic-number dependences of the individual charge-state fractions.

27078 Production of orientation and alignment in heavy-ion—surface collisions. Berry, H.G.; Gabrielse, G.; Livingston, A.E. (Argonne National Laboratory, Argonne, Illinois 60439). *Phys. Rev., A;* **16**: No. 5, 1915-1928(Nov 1977).

We have measured the alignment and orientation parameters of forward-scattered argon ions excited in grazing-incidence collisions with a Cu surface. The polarization of the light emitted from excited scattered ions has been measured simultaneously with a measurement of their spatial position relative to the interaction region. We have measured the dependence of the orientation with ion energy, incidence angle, scattering angle, and surface material. Total ion angular distributions are found to be independent of incident energies between 0.50 and 3.0 MeV. Possible excitation mechanisms for producing the observed charge states, excited states, alignment, and orientation are discussed. We compare this surface excitation with the excitation of ions passing through thin foils.

27079 Distorted-wave theory of electron-ion collisions. I. Direct excitation and ionization. Hahn, Y. (Department of Physics, University of Connecticut, Storrs, Connecticut 06268). *Phys. Rev., A;* **16**: No. 5, 1964-1973(Nov 1977).

A simple modification of the Bethe approximation for high-energy electron-atom collisions is considered for the purpose of analyzing the medium-energy scattering by highly stripped ionic targets. The effect of amplitude and phase distortions of the projectile-electron wave function on the excitation and ionization cross sections is approximately taken into account using the Elwert factor and the eikonal procedure, respectively. To facilitate the cross-section calculation further, the momentum-transfer-dependent part in the excitation matrix element is factored out in terms of an average transfer. The energy dependence of the various modification factors is studied in detail, showing that the distortion effect is large for ionic targets and decays only slowly with the scattering energy, as E/sup -1/2/. For a neutral target, however, the distortion effects roughly cancel with each other, thus resulting in the effectiveness of the unmodified Bethe cross section at much lower energies than one usually expects. The improved formalism is applied to estimate the total cross sections for the direct excitation and ionization of outer-shell electrons of the ionic target. The results are drastically changed from the unmodified Bethe approximation, and are generally in fair agreement with experimental data for all energies except in the threshold region.

27080 Radiative lifetimes of the low-lying levels of Na-like copper. Pegg, D.J.; Griffin, P.M.; Johnson, B.M.; Jones, K.W.; Cecchi, J.L.; Kruse, T.H. (University of Tennessee, Knoxville, Tennessee 37916). *Phys. Rev., A;* **16**: No. 5, 2008-2010(Nov 1977).

Radiative lifetimes (and f values) have been measured for the n = 3 levels of the sodiumlike ion, Cu^{19+}, using the beam-foil method. Strong cascade tails attributable to the decay of long-lived Rydberg or "yrast" levels were observed.

27081 Time-of-flight spectrometer measurements of elastic-scattering cross sections for electrons with energies of 0.04—1.5 eV in He

and Ne. Gus'kov, Y.K.; Savvov, R.V.; Slobodyanyuk, V.A. (Obninsk Physicoenergetics Institute). *High Temp. (USSR) (Engl. Transl.);* **15**: No. 3, 544-546(Nov 1977).

The energy dependences of the cross sections for electron-helium and electron-neon elastic scattering were determined. A modified pulsed pierce gun with a thermionic cathode was used as the electron source.(AIP)

27082 Measurement of the cross sections of copper atoms for excitation by electron impact. Borozdin, V.S.; Smirnov, Y.M.; Sharonov, Y.D. *Opt. Spectrosc. (USSR) (Engl. Transl.);* **43**: No. 2, 227-228(Aug 1977).

Excitation functions were measured using an intersecting beam apparatus for the excitation of copper atoms in their ground state by electron impact. The optical range 210—850 nm was studied. (AIP)

27083 Angular distribution of electrons emitted in electron-impact ionization of helium atoms. Mishchenko, T.V.; Senashenko, V.S.; Strakhova, S.I. *Opt. Spectrosc. (USSR) (Engl. Transl.);* **43**: No. 1, 16-18(Jul 1977).

Using the wave function of the continuous spectrum obtained with the potential for a frozen He^+ core, calculations are made in the first Born approximation, taking exchange into account, for the angular distributions of electrons emitted in electron-impact ionization of helium atoms. The results of these calculations agree with experimental data and reproduce very fine details of the angular distributions in the region of large angles of ejection.

ATOMIC AND MOLECULAR THEORY

27084 Photoabsorption in molecular nitrogen: A moment analysis of discrete-basis-set calculations in the static-exchange approximation. Rescigno, T.N.; Bender, C.F.; McKoy, B.V.; Langhoff, P.W. (Theoretical Atomic and Molecular Physics Group, University of California, Lawrence Livermore Laboratory, Livermore, California 94550). *J. Chem. Phys.;* **68**: No. 3, 970-982(1 Feb 1978).

Theoretical investigations of photoexcitation and ionization cross sections in molecular nitrogen are reported employing the recently devised Stieltjes—Tchebycheff moment-theory technique in the static-exchange approximation. The coupled-channel equations for photoabsorption are separated approximately by identifying the important physically distinct excitation processes associated with formation of the three lowest electronic states of the parent molecular ion. Approximate Rydberg series and pseudospectra of transition frequencies and oscillator strengths are constructed for the seven individual channel components identified using Hartree—Fock ionic core functions and normalizable Gaussian orbitals to describe the photoexcited and ejected electrons. Detailed comparisons of the theoretically determined discrete excitation series with available spectral data indicate general accord between the calculated and observed excitation frequencies and oscillator strengths, although there are some discrepancies and certain Rydberg series have apparently not yet been identified in the measured spectra. The total Stieltjes—Tchebycheff vertical photoionization cross section obtained from the discrete pseudospectra is in excellent agreement with recent electron—ion coincidence measurement of the cross section for parent—ion production from threshold to 50 eV excitation energy. Similarly, e calculated vertical partial cross sections for the production of the three lowest electronic states in the parent molecular ion are in excellent accord with the results of recent electron—electron coincidence and synchrotron—radiation branching ratio measurements. The origins of particularly intense resonancelike features in the discrete and continuum portions of the photoabsorption cross sections are discussed in terms of excitations into valencelike molecular orbitals.

27085 Coherent dynamics of N-level atoms and molecules. I. Numerical experiments. Eberly, J.H.; Shore, B.W.; Bialynicka-Birula, Z.; Bialynicki-Birula, I. (Department of Physics and Astronomy, University of Rochester, Rochester, New York 14627). *Phys. Rev., A;* **16**: No. 5, 2038-2047(Nov 1977).

We study numerically the solution to Schroedinger's equation for the radiative interaction of fictitious N-level model atomic and molecular systems with monochromatic radiation fields. The numerical method of solution allows us to study multiphoton transitions in N-level systems unhampered by the assumptions usually adopted, such as weak fields or large detunings of intermediate states, in perturbative and quasiperturbative analytic studies. We point out regularities and near regularities in the population dynamics that appear to be qualitatively different from those encountered in two- and three-level systems.

27086 Coherent dynamics of N-level atoms and molecules. II. Analytic solutions. Bialynicka-Birula, Z.; Bialynicki-Birula, I.; Eberly, J.H.; Shore, B.W. (Institute of Physics, Polish Academy of Science, 02-668 Warsaw, Poland). *Phys. Rev., A;* **16**: No. 5, 2048-2054(Nov 1977).

We show that a class of multiphoton-absorption problems has exact solutions. In these problems an N-level atom or molecule absorbs energy from near-resonance monochromatic laser fields, and one asks for the time-dependent populations of the energy levels of the absorber. We find that the equal-Rabi and the harmonic-Rabi N-level systems studied numerically in the preceding paper are associated with Chebyshev and Hermite polynomials. Using the exact solutions we find exact expressions for the time averages of occupation probabilities in terms of sums of squares of polynomials. In addition we find the first approximate analytic expression for the long-period population oscillations observed in numerical solutions; and we show that a steady-state population inversion between the highest and lowest levels may be maintained by multiphoton pumping.

GENERAL FLUID DYNAMICS

27087 Pressure generation due to a temperature discontinuity at a liquid-liquid plane interface. Cooper, F.; Blewett, P. (Theoretical and Energy Divisions, Los Alamos Scientific Laboratory, Los Alamos, New Mexico 87545). *Phys. Fluids;* **21**: No. 3, 334-346(Mar 1978).

Using a simplified equation of state, an analytic solution for the temperature, pressure, velocity, and acceleration of two semi-infinite liquids initially at two distinct temperatures is obtained by ignoring the effects of the generated pressure on the temperature distribution. It is found that the pressure wave generated in the cooler medium by the temperature discontinuity develops into a shock after passing through the thermal boundary layer. The cooler material is initially accelerated into the hotter material and thus if the cooler material is lighter, the interface is Raleigh—Taylor unstable. The pressures and velocities at the interface relax with a characteristic time tau=α/c^2, where α is the thermal diffusivity and c is the speed of sound. For the particular case of liquid Na in contact with liquid UO_2 specific results are given. The linearized approximation is compared with exact numerical integration of the full hydrodynamic equations and reasonable agreement is found.

27088 Use of one-dimensional Cosserat theory to study instability in a viscous liquid jet. Bogy, D.B. (Department of Mechanical Engineering, University of California, Berkeley, California 94720). *Phys. Fluids;* **21**: No. 2, 190-197(Feb 1978).

The problem of the instability of an incompressible viscous liquid jet is considered within the context of one-dimensional Cosserat equations. Linear stability analyses are performed for both the infinite and semi-infinite jets. The results obtained for the inviscid case are compared with the corresponding results derived from ideal fluid equations. They are also compared with recent results by other authors obtained from a different set of one-dimensional jet equations. Solutions are also obtained, within the framework of the linearized theory, to the jet break-up problems formulated as an initial-value problem for the infinite jet and as a boundary-value problem for the semi-infinite jet.

27089 Stability of ablation and combustion fronts. Baker, L. (Plasma Theory Division, Sandia Laboratories, Albuquerque, New Mexico 87115). *Phys. Fluids;* **21**: No. 2, 295-297(Feb 1978).

An analytic model is developed to examine the stability of ablation fronts (as in laser and particle beam produced implosions) and combustion fronts.

27090 Mode crossing in a Lagrangian system. Rosenbluth, M.N. (The Institute for Advanced Study, Princeton, New Jersey 08540). *Phys. Fluids;* **21**: No. 2, 297-298(Feb 1978).

By use of the Lagrangian formalism a simple criterion is derived for the stability of a mode crossing in a slightly nondegenerate fluid, or Vlasov plasma.

27091 Accelerated iterative calculation of transonic nacelle flowfields. Caughey, D.A. (McDonnell Douglas Corp., St. Louis); Jameson, A. *AIAA (Am. Inst. Aeronaut. Astronaut.) J.;* **15**: No. 10, 1474-1480(Oct 1977).

A method is presented for the calculation of inviscid, supercritical flowfields about axisymmetric inlet cowls. A finite-difference calculation is performed in a simple, rectangular domain obtained from the nacelle geometry by a nearly conformal mapping procedure. Type-dependent finite differences are constructed using a coordinate-independent, "rotated" differencing scheme. Methods of accelerating convergence of the iterative solution are demonstrated including a hybrid fast-Poisson-solver/relaxation scheme and an extrapolated relaxation procedure. Calculated pressure distributions are compared with experimental data for a variety of Mach numbers and mass flow ratios, and show generally good agreement.

PROPERTIES AND STRUCTURE OF FLUIDS

27092 Use of boundary layer theory to determine the internal circulation of falling drops. Klett, J.D. (Los Alamos Scientific Lab., NM). *J. Atmos. Sci.;* **34**: No. 3, 551-552(Mar 1977).

The standard boundary layer model for the flow past a circulating drop neglects the stress reduction caused by motion of the drop surface. A modified boundary layer model which incorporates this effect is presented, and is shown to yield good agreement with a numerical solution for the strength of the drop internal circulation. 1 table.

MAGNETOHYDRODYNAMICS

27093 (UCRL—79860) **Ponderomotive force in a hydrodynamic simulation code.** Harte, J.; Zimmerman, G. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 6 Oct 1977. Contract W-7405-ENG-48. 25p. (CONF-771136—7). Dep. NTIS, PC A02/MF A01.

From Annual American Physical Society meeting; Atlanta, GA, USA (7 Nov 1977).

For laser intensities approximately 3 x 10^{15} watts/cm^2 the radiation pressure of 1.06 μm light is equivalent to the pressure of a 1 keV hydrogen plasma at the critical density. Experiments indicate and particle simulations predict significant profile modification by the ponderomotive force. An algorithm to calculate the ponderomotive force in the hydrodynamic approximation is described, and its implementation in the LASNEX code. The algorithm was derived by demanding that momentum be conserved and by using the WKB solution for the fields. In this approximation the algorithm is identical with the corresponding analytic expression, i.e., the divergence of the radiation pressure tensor including absorption. The oscillatory character of the force is not present. Sample calculations show steady state profiles with density steps at the critical surface which are consistent with predicted values.

27094 Boundary-layer blockage with mass transfer. Hokenson, G.J. (STD Research Corp., Arcadia, CA). *AIAA (Am. Inst. Aeronaut. Astronaut.) J.;* **15**: No. 10, 1529-1530(Oct 1977).

It is noted that, because of the origin of the shape factor as a definition based on δ^* and θ, the dependence of the shape factor on mass transfer may be exposed directly from considerations of mass continuity. In so doing, it is necessary to utilize only the physical interpretation of δ^* and the fact that mass transfer appears as an explicit term in the momentum equation. A prerequisite to this approach is the development of an appropriate skin friction coefficient model with mass transfer in a pressure gradient.

SUPERFLUIDITY

27095 (AD—239477) **Transport properties of helium II in fine channels.** BURNHAM, J.; REPPY, J. (Connecticut Univ., Storrs (USA)). 30 Sep 1960. Contract nonr296700. 18p. NTIS PC A02/MF A01.

27096 Hydrodynamics of Fermi superfluids. Broglia, R.A.; Molinari, A.; Regge, T. (State University of New York at Stony Brook, Stony Brook, New York 11794). *Ann. Phys. (N.Y.);* **109**: No. 2, 349-364(Dec 1977).

The hydrodynamic of a neutral Fermi fluid is derived from the microscopic pairing model in the framwork of a time dependent BCS formalism. A discussion of a superfluidity and coherence properties of these fluids and a comparison with the known He II hydrodynamics is attempted. Applications to finite nuclear systems are discussed.

PARTICLE INTERACTIONS AND PROPERTIES - EXPERIMENTAL

ELECTROMAGNETIC INTERACTIONS

REFER ALSO TO CITATION(S) 27112, 27119, 27136, 27137

27097 (ORO—4043-37) **Experiments on the nuclear interactions of pions and electrons. Progress report, December 1, 1976—November 30, 1977.** McCarthy, J.S.; Minehart, R.C.; Ziock, K.O.H. (Virginia Univ., Charlottesville (USA)). 1977. Contract EY-76-S-05-4043. 103p. Dep. NTIS, PC A06/MF A01.

Separate abstracts were prepared for the nine papers of interest. (JFP)

27098 (SLAC-PUB—1624) **e^+e^- annihilation into hadrons at SPEAR.** Feldman, G.J. (Stanford Linear Accelerator Center, Calif. (USA)). Aug 1975. Contract EY-76-S-03-0326. 11p. (CONF-750654—61). Dep. NTIS, PC A02/MF A01.

From High energy particle physics divisional conference of EPS; Palermo, Italy (23 Jun 1975).

The review of e^+e^- annihilation includes the detectors, total hadronic cross sections, charged multiplicity, and inclusive distributions. The new particles are excluded. Some results on the search for new particles, searches for monochromatic photons from the psi[1], a search for nonleptonic decays of charmed mesons, and evidence for anomalous lepton production are also given. 20 references. (JFP)

27099 (SLAC-PUB—1728) **psi and excess leptons in photoproduction.** Ritson, D.M. (Stanford Univ., Calif. (USA)). Mar 1976. Contract EY-76-S-03-0326. 8p. (CONF-760344—4). Dep. NTIS, PC A02/MF A01.

From Conference on particle searches and discoveries; Nashville, TN, USA (1 Mar 1976).

The A-dependence of psi photoproduction was measured on beryllium and tantalum. From this it is found sigma/sub psi N/ = 2.75 +- 0.90 mb. A study was made of excess leptons relative to pion production in photoproduction. A μ/π ratio of 1.40 +- 0.25 x 10^{-4} was found at 20 GeV incident photon energy. The energy dependence of psi photoproduction was determined and appeared to have a "pseudo-threshold" at 12 GeV.

27100 (SLAC-PUB—1737) **Production of new particles and muon-electron events in e^+-e^- annihilation at spear.** Richter, B. (European Organization for Nuclear Research, Geneva (Switzerland); Stanford Linear Accelerator Center, Calif. (USA)). Apr 1976. Contract EY-76-S-03-0326. 59p. (CONF-7603114—1). Dep. NTIS, PC A04/MF A01.

From Royal Society on - New Particles and New Quantum Numbers; London, UK (11 Mar 1976).

The new states, their properties and decays, total hadron cross sections, and the muon—electron events in e^+e^- annihilation are reviewed. 19 references. (JFP)

27101 (SLAC-PUB—1745) **Nonresonant multibody production by e^+e^- annihilation.** Feldman, G.J. (Stanford Linear Accelerator Center, Calif. (USA)). May 1976. Contract EY-76-S-03-0326. 14p. (CONF-760262—1). Dep. NTIS, PC A02/MF A01.

From International meeting on storage ring physics; Flaine, France (22 Feb 1976).

Several aspects of nonresonant multibody production by e^+e^- annihilation are reviewed. At high energies the ratio of the hadronic cross section to the μ pair production cross section is consistent with being constant; inclusive distributions show approximate Bjorken scaling; and there is strong evidence for jet-like structure. The jets are produced with an angular distribution characteristic of that of pairs of spin $1/2$ particles.

27102 Inclusive production of rho^0 in inelastic muon-nucleon scattering. del Papa, C.; Dorfan, D.; Flatte, S.M.; Heusch, C.A.; Lieberman, B.; Moss, L.; Schalk, T.; Seiden, A.; Bunnell, K.; Duong-van, M.; Mozley, R.; Odian, A.; Villa, F.; Wang, L.C. (University of California, Santa Cruz, California 95064). *Phys. Rev. Lett.;* **40**: No. 2, 90-93(9 Jan 1978).

We measured the inclusive production of rho^0 mesons in virtual-photon—nucleon collisions. The extracted structure functions are Q^2 independent and approximately equal to those observed in photoproduction, if one excludes the diffractive (elastic) region where a large decrease is observed. A significant fraction of the inclusive π^{+-} distribution results from the decay of these rho^0's.

27103 Inclusive baryon production in e^+e^- annihilation. Piccolo, M.; Peruzzi, I.; Lueke, D. (Stanford Linear Accelerator Center and Department of Physics, Stanford University, Stanford, California 94305). *Phys. Rev. Lett.;* **39**: No. 24, 1503-1506(12 Dec 1977).

The inclusive production of antiprotons and Λ's in e^+e^- annihilation has been measured as a function of the c.m. energy in the range 3.7—7.6 GeV. We find that the baryon cross section has a behavior different from the total hadronic production. Our results show a rapid rise in the ratio σ/sub p//σ/sub mumu/between 4.4 and 5 GeV, consistent with what would be expected from charmed baryon production. Lambda-bar production is 10—15% of p-bar production at all energies.

27104 Electroproduction of inclusive pions at high Q^2. Bebek, C.J.; Brown, C.N.; Kline, R.V.; Pipkin, F.M.; Raither, S.W.; Sisterson, L.K.; Browman, A.; Hanson, K.M.; Larson, D.; Silverman, A. (High Energy Physics Laboratory, Harvard University, Cambridge, Massachusetts 02138). *Phys. Rev., D;* **16**: No. 7, 1986-2015(1 Oct 1977).

This paper reports measurements of the inclusive pion electroproduction reaction $e + N \rightarrow e + \pi^{+-}$ with both proton and neutron targets for pions produced along and near the direction of the virtual photon. Two independent purposes of these measurements were to provide data at low ϵ and at high Q^2. Data are reported for the (W,Q^2,ϵ) points (2.2 GeV, 1.2 GeV^2, 0.45), (2.7, 2.0,

0.35), (2.7, 3.3, 0.40), (2.7, 6.2, 0.40), and (2.7, 9.5, 0.40). The data are used to test Feynman scaling and to compare the ratio of the cross sections for charged-pion production to the quark-model predictions. The data are also used in conjunction with the data from earlier experiments to separate the scalar and transverse components of the cross section.

27105 Asymmetry of the cross section of the photoproduction of eta mesons by polarized photons in the resonant energy region. Abramyan, L.O.; Avakyan, R.O.; Agan'yants, A.O.; Adamyan, F.V.; Armaganyan, A.A.; Vortanov, Y.A.; Vartapetyan, G.A.; Galumyan, P.I.; Demekhina, N.A.; Kazaryan, G.K.; Lebedev, A.N.; Manukyan, Z.V.; Muradyan, E.M.; Piliposyan, S.E.; Surunyan, A.M.; Skhtoryan, E.S.; Khudoveryan, A.G.; Khurshudyan, L.S. *JETP Lett. (USSR) (Engl. Transl.);* **25**: No. 12, 560-564(20 Jun 1977).

We measured the asymmetry of the cross section of the reaction $\gamma+p\rightarrow eta^0+P$ at linearly polarized photon energies 1.39, 1.53, and 1.78 GeV and at an eta^0-meson emission angle 46^0 in the c.m.s. The results are compared with the calculated ones assuming contributions from different resonances.

WEAK INTERACTIONS

REFER ALSO TO CITATION(S) 27097

27106 (BNL—23513) **Experimental limits on heavy lepton production by neutrinos.** Cnops, A.M.; Connolly, P.L.; Kahn, S.A. (Brookhaven National Lab., Upton, N.Y. (USA); Columbia Univ., New York (USA)). 1977. Contract EY-76-C-02-0016. 9p. (CONF-770883—2). NTIS, MF A01.

From Symposium on lepton and photon interactions at high energies; Hamburg, F.R. Germany (25 Aug 1977).

Portions of document are illegible.

A search was made for heavy charged leptons decaying semileptonically into e^{+-} in a neutrino exposure of the Fermilab 15 feet bubble chamber filled with a heavy-neon hydrogen mixture. If the heavy lepton couples to ν/sub μ/ with full (V—A) strength, then its mass must be greater than 7.5 GeV if negative and 9.0 GeV, if positive. If the 1.9 GeV tau-meson does couple to ν/sub μ/, then the ν/sub μ/—tau coupling strength must be less than 2.5 percent of the ν/sub μ/-μ coupling.

27107 (SLAC-PUB—1733) **Constituent models and large transverse momentum reactions.** Brodsky, S.J. (Stanford Linear Accelerator Center, Calif. (USA)). Apr 1976. Contract EY-76-S-03-0326. 60p. (CONF-750754—4). Dep. NTIS, PC A04/MF A01.

From Summer Institute on Particle Physics; Stanford, CA, USA (21 Jul 1975).

In the lectures on constituent models and large transverse momentum reactions the simplifying assumptions are made that large transverse momentum reactions can be analyzed in terms of short distance interactions—independent of the large distance confinement problem, and that the basic quark-quark interactions within a hadron is scale-independent as in asymptotic freedom gauge theories. A new argument, minimum neutralization, is also presented to account for the empirical absence of gluon interactions between quarks of different hadrons. The structure of hard scattering models, dimensional counting rules, dimensional counting and exclusive processes, the deuteron form factor, applications to inclusive reactions, predictions for meson and photon beams, and the charge-cubed test: the $e^{+-}p$ yields $e^{+-}p$ asymmetry are discussed. Also presented are quasi-elastic peak in inclusive hadronic reactions, correlations, multiplicity bump at large P/sub t/, the partition method for bound state calculations, proofs of dimensional counting, minimal neutralization and quark-quark scattering, constituent-interchange model, and the A-dependence of high P/sub t/ reactions. 66 references. (JFP)

27108 (SLAC-PUB—1822) **Some results in $\mu h^{+-}X$ process.** Duong-van, M. (Stanford Linear Accelerator Center, Calif. (USA)). Oct 1976. Contract EY-76-S-03-0376. 6p. (CONF-760719—37). Dep. NTIS, PC A02/MF A01.

From 18. international conference on high energy physics; Tbilisi, USSR (15 Jul 1976).

Two small aspects of deep inelastic particle production obtained from a 14-GeV/c μ^+ beam on a hydrogen target in the region $Q^2 = 0.3 - 4$ GeV^2 and $\nu = 2 - 12$ GeV. The semi-inclusive structure function is considered as a function of Q^2 and s. The structure of detected hadrons in $\mu p \rightarrow \mu h^{+-} + X$ and the charge ratio $R = h^+/h^-$ are treated. Six references. (JFP)

27109 (SLAC-PUB—1923) **Evidence for, and properties of, the new charged heavy lepton.** Perl, M.L. (Stanford Linear Accelerator Center, Calif. (USA)). Apr 1977. Contract EY-76-S-03-0376. 23p. (CONF-770319—6). NTIS, MF A01.

From 12. Rencontre de Moriond; Haute-Savoie, France (6 Mar 1977).

The evidence for, and the properties of, the mass 1.9 +- .1 GeV/c^2 charged heavy lepton recently found in e^+e^- annihilation are summarized.

27110 (SLAC-PUB—1991) **Comments on the tau heavy lepton.** Perl, M.L. (Stanford Linear Accelerator Center, Calif. (USA)). Aug 1977. Contract EY-76-S-03-0326. 15p. (CONF-770406—5). Dep. NTIS, PC A02/MF A01.

From 5. international conference on experimental meson spectroscopy; Boston, MA, USA (29 Apr 1977).

There is now substantial published evidence for the existence of a new charged particle of mass 1.9 GeV/c which decays through the weak interaction. All this evidence is in agreement with the particle being a new lepton, which is called the tau. Measurements from the data of the SLAC-LBL Magnetic Detector Collaboration of the tau mass, of the mass of the associated neutrino, of the coupling of the tau to the associated neutrinos, and of the decay modes are presented. Also discussed is the evidence for the tau being a sequential heavy lepton.

27111 (SLAC-PUB—1996) **Summary talk: neutrino '77.** Bjorken, J.D. (Stanford Linear Accelerator Center, Calif. (USA)). Aug 1977. Contract EY-76-S-03-0326. 24p. (CONF-770696—5). Dep. NTIS, PC A02/MF A01.

From International conference on neutrino physics and neutrino astrophysics; Elbrus, USSR (18 Jun 1977).

The summary of neutrino physics includes astrophysics, charm, the heavy lepton tau, more building blocks, understanding of the structure functions, the correctness of the standard SU(2) x U(1) model, and exotica as seen from a particular gauge theory. 35 references (JFP)

27112 (SLAC-PUB—2055) **Evidence for, and properties of the tau lepton.** Perl, M.L. (Stanford Linear Accelerator Center, Calif. (USA)). Dec 1977. Contract EY-76-S-03-0326. 25p. (CONF-7710107—1). Dep. NTIS, PC A02/MF A01.

From Conference on parity nonconservation, weak neutral currents and gauge theories; Batavia, IL, USA (20 Oct 1977).

An outline of the evidence on the e^+e^- annihilation of a new charged lepton, the tau, is presented. Measured properties of the tau are summarized and some still open questions as to its properties are discussed.

27113 Observation of D^0-meson decay into $K^-\pi^+\pi^0$. Scharre, D.L.; Barbaro-Galtieri, A.; Dorfan, J.M.; Ely, R.; Feldman, G.J.; Feller, J.M.; Fong, A.; Gobbi, B.; Hanson, G.; Jaros, J.A.; Kwan, B.P.; Lecomte, P.; Litke, A.M.; Lueke, D.; Madaras, R.J.; Martin, J.F.; Miller, D.H.; Parker, S.I.; Perl, M.L.; Peruzzi, I.; Piccolo, M.; Pun, T.P.; Rapidis, P.A.; Ronan, M.T.; Ross, R.R.; Trippe, T.G.; Vuillemin, V.; Yount, D.E. (Stanford Linear Accelerator Center and Department of Physics, Stanford University, Stanford, California 94305). *Phys. Rev. Lett.;* **40**: No. 2, 74-76(9 Jan 1978).

In a sample of multihadron events with a π^0 from e^+e^- annihilation data at 3.77-GeV center-of-mass energy, we observe the decay $D^0 \rightarrow K^-\pi^+\pi^0$ with direct observation of the π^0. The observed branching fraction is (12 +- 6) %.

27114 Observation of μe events in anti ν and ν interactions in neon. Ballagh, H.C.; Bingham, H.H.; Bosetti, P.; Fretter, W.B.; Gee, D.; Grivaz, J.; Lynch, G.R.; Marriner, J.P.; Orthel, J.; Porter, F.C.; Sokoloff, M.D.; Stevenson, M.L.; Yost, G.P.; Cence, R.J.; Harris, F.A.; Jones, M.D.; Katsura, T.; Parker, S.I.; Peterson, V.Z.; Peters, M.W.; Stenger, V.J.; Burnett, T.H.; Csorna, S.; Lubatti, H.J.; Moriyasu, K.; Rudnicka, H.; Swider, G.M.; Yuldashev, B.S. (University of California and Lawrence Berkeley Laboratory, Berkeley, California 94720). *Phys. Rev. Lett.;* **39**: No. 26, 1650-1653(26 Dec 1977).

Based on four μ^+e^-X and six μ^-e^+X events (with estimated backgrounds 1.1 and 0.6 events respectively), in the Fermilab 15-in. neon (64 at. %) hydrogen bubble chamber, the fractions of μ^+e^- and μ^-e^+ production relative to nu-bar/sub μ/and ν/sub μ/charged-current interactions in a broad band nu-bar beam are, respectively, f-bar = (0.15/sup +0.14//sub 0.08/) % and f = (0.34/sup +0.23//sub -0.13/) %; f-bar/f = 0.45/sup +0.6//sub -0.3/.

27115 Measurements of ν/sub μ//sub N/and ν-bar/sub μ//sub N/charged-current total cross sections. Barish, B.C.; Bartlett, J.F.; Bodek, A.; Brown, K.W.; Buchholz, D.; Chu, Y.K.; Sciulli, F.; Siskind, E.; Stutte, L.; Fisk, H.E.; Krafczyk, G.; Nease, D.; Fackler, O. (California Institute of Technology, Pasadena, California 91125). *Phys. Rev. Lett.;* **39**: No. 25, 1595-1598(19 Dec 1977).

Measurements of flux-normalized neutrino and antineutrino total charged-current cross sections (σ) in the energy range $45 < E < 205$ GeV are presented. We see no evidence for the anomalous sharp rise in σ/sub ν-barν/ reported by earlier authors. The neutrino cross section rises linearly with energy and with σ/E about 18% smaller than other meaurements below 10 GeV. The average antineutrino slope at 55 GeV is consistent with measurements at low energy; however, a (20 +- 10) % increase is indicate over our energy range.

27116 Neutrino interactions in hydrogen and deuterium: Description of the experiment and study of the reaction $\nu + d \rightarrow \mu^- + p +$ p/sub s/. Barish, S.J.; Campbell, J.; Charlton, G.; Cho, Y.; Derrick, M.; Engelmann, R.; Hyman, L.G.; Jankowski, D.; Mann, A.; Musgrave, B.; Schreiner, P.; Schultz, P.F.; Singer, R.; Szczekowski, M.; Wangler, T.; Yuta, H.; Barnes, V.E.; Carmony, D.D.; Garfinkel, A.F.; Radecky, G.M. (Argonne National Laboratory, Argonne, Illinois 60439). *Phys. Rev., D;* **16**: No. 11, 3103-3121(1 Dec 1977).

This paper gives a detailed description of an experiment which studies the interactions of muon-type neutrinos in hydrogen and deuterium. The experiment was performed at the Zero Gradient Synchrotron using the wide-band neutrino beam incident on the Argonne 12-foot bubble chamber filled with hydrogen and deuterium. The neutrino energy spectrum peaks at 0.5 GeV and has a tail extending to 6 GeV. The shape and intensity of the flux is determined using measurements of pion yields from beryllium. The produced pions are focused by one or (for the latter part of the experiment) two magnetic horns. A total of 364 000 pictures were taken with a hydrogen filling of the bubble chamber and 903 000 with a deuterium filling. The scanning and other analyses of the events are described. The most abundant reaction occurs off neutrons and is quasi-elastic scattering $\nu d \rightarrow \mu^- pp$/sub s/. The separation of these events from background channels is discussed. The total and differential cross sections are analyzed to obtain the axial-vector form factor of the nucleon. Our result, expressed in terms of a dipole form factor, gives an axial-vector mass of 0.95 +- 0.09 GeV. A comparison is made to previous measurements using neutrino beams, and also to determinations based upon threshold pion electroproduction experiments. In addition, the data are used to measure the weak vector factor and so check the conserved-vector-current hypothesis.

27117 Measurement of the angular correlation parameters in the β decay of polarized Λ hyperons. Lindquist, J.; Swallow, E.C.; Sumner, R.L.; Watson, J.M.; Winston, R.; Wolfe, D.M.; Reibel, K.; Schwartz, D.M.; Stevens, A.J.; Romanowski, T.A. (Enrico Fermi Institute, The University of Chicago, Chicago, Illinois 60637). *Phys. Rev., D;* **16**: No. 7, 2104-2114(1 Oct 1977).

We present our final results from an experimental investigation of the β decay of polarized Λ hyperons with a large-aperture magnetic spectrometer. Our data sample consists of 544 events. We obtain A/sub ν/A/sub e/ = 0.05 +- 0.12, and A/sub p/ = -0.47 +- 0.12 for the three spin-asymmetry parameters, and A/sub e/sub ν// for the electron-neutrino correlation. The lepton-plane correlation with the Λ spin, D = 0.11 +- 0.20, is consistent with no violation of time-reversal invariance. Our data yield an axial-vector-to-vector form-factor ratio of $g_1/f_1 = 0.53$/sup +0.22//sub -0.09/. The Cabibbo-model value is $g_1/f_1 = 0.71$.

27118 Search for a new short-lived particle in collisions of 70 GeV/c protons with emulsion nuclei. Bannik, B.P.; Bobodzhanov, I.; Salomov, D.A.; Sun-Tszin-Yan, G.Y.; Tolstov, K.D.; Khoshmukhamedov, R.A.; Sharbatova, G.S.; El'-Nagi, A. (Joint Institute for Nuclear Research; Physicotechnical Institute of the Tadzhik Academy of Sciences). *JETP Lett. (USSR) (Engl. Transl.);* **25**: No. 12, 550-553(20 Jun 1977).

In a study of approximately 14,000 interactions between protons and emulsion nuclei we registered three events that can be interpreted as a weak decay of new particles with a lifetime $\sim 10^{-14}$ sec. The cross section for the generation of these particles is 5 μb.

STRONG BARYON-INDUCED INTERACTIONS

REFER ALSO TO CITATION(S) 27145, 27226

27119 (SLAC-PUB—1806) Recent developments in the theory of large transverse momentum processes. Brodsky, S.J.; Gunion, J.F. (Stanford Linear Accelerator Center, Calif. (USA); California Univ., Davis (USA). Dept. of Physics). Aug 1976. Contract EY-76-S-03-0376. 20p. (CONF-760672—5; CONF-760719—38). Dep. NTIS, PC A02/MF A01.

From 7. international colloquium on multiparticle reactions; Tutzing, F.R. Germany (21 Jun 1976).

The evidence for the ruling out of the basic large p/sub t/ mechanism expected to be related to elementary quark - quark scattering is briefly reviewed and a comparison is presented with the predictions of the constituent interchange model which postulated that the important subprocesses involve quark-hadron scattering. Proton-proton, electron-proton, and pion-proton inclusive interactions are discussed. 30 references (JFP)

27120 (TID—28065) Colliding pomerons-experimental situation and outlook. Kernan, A. (California Univ., Riverside (USA)). 24 Mar 1977. 15p. Dep. NTIS, PC A02/MF A01.

Recent experimental studies of "Double Pomeron Exchange" at FNAL and the CERN ISR are reviewed.

27121 Inclusive charged-particle production in neutron-nucleus collisions. Chaney, D.; Ferbel, T.; Mollet, W.; Slattery, P.; Underwood, D.; Bleser, E.; Johnson, D.; Gobbi, B.; Keren, J.; Lipton, R.; Rosen, J.; Ruchti, R.; Spelbring, D. (Department of Physics and Astronomy, University of Rochester, Rochester, New York 14627). *Phys. Rev. Lett.;* **40**: No. 2, 71-74(9 Jan 1978).

We have measured inclusive particle production in neutron-nucleus collisions at high energies. Data on positive and negative particles produced in nuclei, ranging in size from Be to Pb, are presented for essentially the full forward hemisphere in the center-of-mass system. Fits of the form A/sup α/to the invariant production cross section indicate that α changes from $\sim$0.85 to $\sim$0.55 for laboratory rapidities ranging from 3 to 8. Multiperipheral models which invoke cut contributions to particle production in nuclei predict such behavior.

27122 Evidence against copious threshold pion production in heavy-ion collisions. Lindstrom, P.J.; Crawford, H.J.; Greiner, D.E.; Hagstrom, R.; Heckman, H.H. (Lawrence Berkeley Laboratory and Space Sciences Laboratory, University of California, Berkeley, California 94720). *Phys. Rev. Lett.;* **40**: No. 2, 93-96(9 Jan 1978).

In a recent publication, McNulty et al. reported a very high pion multiplicity in relatively low-energy heavy-ion interactions in nuclear emulsion. Using an emulsion stack virtually identical to theirs we find a pion multiplicity at least a factor of 30 smaller. We show here that the previously reported multiplicity was based on an erroneous identification of high-energy protons as pions.

27123 Coherent dissociation of neutrons on nuclei at 100—300 GeV/c. Mollet, W.; Biel, J.; Ferbel, T.; Slattery, P.; Underwood, D.; Gobbi, B.; Kenah, L.; Rosen, J.; Ruchti, R.; Bleser, E.; Freytag, D. (University of Rochester, Rochester, New York 14627). *Phys. Rev. Lett.;* **39**: No. 26, 1646-1649(26 Dec 1977).

We have studied the coherent dissociation of neutrons into $p\pi^-$ systems, for a variety of nuclear targets, at incident momenta up to 300 GeV/c. Using a model incorporating both electromagnetic and hadronic production, we have extracted total cross sections for scattering of unstable $p\pi^-$ systems on nucleons.

27124 Energy dependence of the pseudorapidity distributions in proton-nucleus collisions between 50 and 200 GeV/c. Halliwell, C.; Elias, J.E.; Busza, W.; Luckey, D.; Votta, L.; Young, C. (Physics Department, Carleton University, Ottawa, Ontario K1S 5B6, Canada). *Phys. Rev. Lett.;* **39**: No. 24, 1499-1502(12 Dec 1977).

Pseudorapidity distributions for proton-nucleus interactions are presented. The data cover twelve nuclei ranging from carbon to uranium and three incident proton momenta, 50, 100, and 200 GeV/c.

27125 Diffractive process in six-prong proton-proton interactions at 205 GeV/c. Derrick, M.; Musgrave, B.; Schreiner, P.; Schultz, P.F.; Szczekowski, M.; Yuta, H. (Argonne National Laboratory, Argonne, Illinois 60439). *Phys. Rev., D;* **16**: No. 11, 3122-3126(1 Dec 1977).

We have studied the 6-prong events in a 50 000-picture exposure of the Fermilab 30-inch hydrogen bubble chamber to a 205-GeV/c proton beam. The data consist of complete measurements of 442 events, each containing a proton track with P/sub lab/ < 1.4 GeV/c. A low-mass diffractive peak is seen in the events with 5 charged particles in the forward center-of-mass hemisphere. An analysis based on the rapidity distributions of the outgoing tracks and the missing mass gives a single diffractive cross section of 0.88 +- 0.12 mb for both hemispheres of which the final state $pp\pi^+\pi^-\pi^-$ contributes 0.18 +- 0.07 mb. In the diffractive sample, only 0.20 +- 0.06 mb corresponds to events decaying through an intermediate state containing a Δ^{++}. We measure an upper limit for the double diffraction cross section of 0.38 +- 0.12 mb.

27126 Charged-particle multiplicity distributions in 100-GeV/c pd, π^+d, p-nucleon, and π-nucleon interactions. Lys, J.E.A.; Murphy, C.T.; Binkley, M.; Dado, S.; Engler, A.; Keyes, G.; Kraemer, R.W.; Brody, A.; Hanlon, J.; Seidl, A.A.; Toothacker, W.S.; VanderVelde, J.C. (Fermi National Accelerator Laboratory, Batavia, Illinois 60510). *Phys. Rev., D;* **16**: No. 11, 3127-3136(1 Dec 1977).

In an experiment in the Fermilab 30-inch deuterium bubble chamber, we have determined the pd and π^+d charged-particle multiplicity distributions. We use corrected odd-prong distributions plus a no-cascade model to extract the pn and π^+n multiplicity distributions, and indicate how a cascade model could alter the distributions. We examine the relations between pn and pp, and π^+n and π^-p, multiplicity distributions. For each pair, a relation is found involving quantities that give the probability, at each multiplicity, that a struck proton remains a proton. These quantities are evaluated and compared with expectations.

27127 Elastic scattering of 1-GeV protons by nuclei. Boridy, E.; Feshbach, H. (Center for Theoretical Physics, Laboratory for Nuclear Science and Department of Physics, Massachusetts Institute of Technology, Cambridge, Massachusetts 02139). *Ann. Phys. (N.Y.);* **109**: No. 2, 468-484(Dec 1977).

The calculated elastic of 1.04-GeV protons by ^{208}Pb, ^{58}Ni, and ^{40}Ca is compared with experiment. The effects of the spin—orbit potential, Pauli and short-range correlations, variation in the ratio of the real to the imaginary part of the nucleon—nucleon scattering amplitude at 0° are found to have similar effects. Further experiments are required before these effects can be disentangled. changes of the neutron density compared to the proton density can be distinguished. Changes of the neutron density compared to the proton density can be distinguished. The proton polarization by elastic scattering by ^{208}Pb and ^{40}Ca is calculated omitting the effects of correlations.

27128 Inclusive rho° and f° production in 100-GeV/c p anti p interactions. Raja, R.; Murphy, C.T.; Voyvodic, L.; Ansorge, R.E.; Bust, C.P.; Carter, J.R.; Neale, W.W.; Rushbrooke, J.G.; Ward, D.R.; Oh, B.Y.; Pratap, M.; Sionakides, G.; Smith, G.A.; Whitmore, J. (Fermi National Accelerator Laboratory, Batavia, Illinois 60510). *Phys. Rev., D;* **16**: No. 9, 2733-2736(1 Nov 1977).

Inclusive and semi-inclusive rho° production in 100-GeV/c p-barp interactions has been studied as a function of c.m. rapidity and transverse momentum. Cross sections are compared with those for p-barp interactions at other energies, as well as pp and π^{+-}/sup p/ interactions, over the range $\sim 2 <$ p/sub lab/ $<$ 200 GeV/c. A measurement of the f° production cross section has been made. Calculations of the contribution from rho° decay to prompt lepton production are presented.

27129 Inclusive production of Λ° hyperons by 300-GeV protons: A dependence. Heller, K.; Skubic, P.; Overseth, O.E.; Pondrom, L.; Bunce, G.; Handler, R.; March, R.H.; Martin, P.; Sheaff, M.; Devlin, T.; Edelman, B.; Edwards, R.T.; Schachinger, L.; Yamin, P. (Department of Physics, University of Michigan, Ann Arbor, Michigan 48109). *Phys. Rev., D;* **16**: No. 9, 2737-2745(1 Nov 1977).

Inclusive production of Λ° hyperons by 300-GeV protons has been measured at fixed production angles in the laboratory between 0 and 9 mrad and laboratory momenta from 65 to 300 GeV/c. Three different solid targets were used: beryllium, copper, and lead. The A dependence of the data is suggestive of a collision model in which the hadron loses energy and gains transverse momentum as it leaves the nucleus. The experimental results are compared to such a model, and the implications are discussed.

27130 Strong interaction and mass measurements using antiprotonic atoms. Roberson, P.; King, T.; Kunselman, R.; Miller, J.; Powers, R.J.; Barnes, P.D.; Eisenstein, R.A.; Sutton, R.B.; Lam, W.C.; Cox, C.R.; Eckhause, M.; Kane, J.R.; Rushton, A.M.; Vulcan, W.F.; Welsh, R.E. (University of Wyoming, Laramie, Wyoming 82071). *Phys. Rev., C;* **16**: No. 5, 1945-1962(Nov 1977).

X-ray transition energies of antiprotonic atoms formed in targets of ^{6}Li, ^{7}Li, C, Si, P, Fe, Y, Zr, Cs, and Yb have been measured. Level shifts and widths due to the strong interaction were determined. A phenomenological fit to the data using an optical-model potential proportional to the nuclear matter density and to an effective p-bar-nucleon s-wave scattering length yielded [(0.85 +- 0.38) + i (2.66 +- 0.28)] fm for the effective scattering length. In addition, the mass of the antiproton was determined to be 938.229 +- 0.049 MeV from the observed energies of the p-bar x-ray transitions unperturbed by the strong interaction.

27131 Simultaneous measurement of the spin parameters P and C/sub N N/ in pp elastic scattering at 2, 3, 4, and 6 GeV/c. Miller, D.; Wilson, C.; Giese, R.; Hill, D.; Nield, K.; Rynes, P.; Sandler, B.; Yokosawa, A. (Northwestern University, Evanston, Illinois 60201). *Phys. Rev., D;* **16**: No. 7, 2016-2026(1 Oct 1977).

Using the polarized beam facility at Argonne National Laboratory and a polarized proton target, simultaneous measurements of the spin parameter P and the spin correlation term C/sub N N/ were made. Data were obtained and analyzed at beam momenta of 2, 3, 4, and 6 GeV/c in the momentum-transfer-squared interval $0.1 <$ or $=$ vertical-bartvertical-bar $<$ or $=$ 2.8 (GeV/c)^2. A preliminary phase-shift analysis of the 2- and 3-GeV/c data is discussed and a comparison with predictions of a particular Regge-pole model at all four energies is made.

27132 Inclusive Δ^{++}(1232) production in 200-GeV/c π^-p interactions. Biswas, N.N.; Higgins, P.D.; Bishop, J.M.; Bolduc, R.L.; Cason, N.M.; Kenney, V.P.; Rhines, D.S.; Shephard, W.D.; Fortney, L.R.; Goshaw, A.T.; Lamsa, J.W.; Loos, J.S.; Robertson, W.J.; Walker, W.D.; Levman, G.; Sreedhar, V.A.; Yoon, T.S.; Hartner, G.; Patel, P.M. (Department of Physics, University of Notre Dame, Notre Dame, Indiana 46556). *Phys. Rev., D;* **16**: No. 7, 2090-2097(1 Oct 1977).

The production of Δ^{++}(1232) is investigated inclusively and semi-inclusively, and is compared with that of protons. We find differences in the Feynman x distributions for Δ's and protons near x = -1.0, which can be attributed to different exchange contributions in these processes. It is found that not all Δ^{++} come from the diffractively excited target proton. Density matrix elements of the Δ^{++} are in agreement with the predictions of the one-pion-exchange model with absorption.

27133 Psi production and high-mass electron-pair limit in pp collisions at square-roots=52 GeV. Amaldi, E.; Beneventano, M.; Borgia, B. (Rome Univ. (Italy). Istituto di Fisica); Dell, G.F.; Uto, H.; Yuan, L.C.L. (Brookhaven National Lab., Upton, N.Y. (USA)); Dooher, J. (Adelphi Univ., Garden City, N.Y. (USA)). *Lett. Nuovo Cim.;* **19**: No. 5, 152-156(4 Jun 1977).

We have observed at the ISR the production of the psi particle at square-roots=52 GeV with a cross section times e^+e^- branching ratio equal to (12.8+-3.2) x 10^{-33} cm^2. We also obtain an upper limit for the production ratio of e^+e^- pairs of M>5.5 GeV to the psi particle: R<2x10^{-2}.

27134 Effect of the rise of the inelastic interaction cross section on the form of the energy spectrum of cosmic-ray hadrons. Grigorov, N.L. (Nuclear Physics Institute, Moscow State University). *Sov. J. Nucl. Phys. (Engl. Transl.);* **25**: No. 4, 419-426(Apr 1977).

The article discusses the effect of the rise of the cross section for inelastic interaction of hadrons with increase of energy on the form of the energy spectrum of high-energy cosmic-ray hadrons. It is shown that a cross-section rise of the type σ/sup i n/=σ^0 1+[a ln (E/E$_0$)] in the region E>1 TeV is consistent with the experimental data. The fraction of pions with E>1 TeV in the cosmic-ray flux at mountain altitudes is estimated.

27135 Fragmentation of nuclei by high-energy particles. Yakovlev, Y.P. (A. A. Zhdanov Leningrad State University). *Sov. J. Particles Nucl. (Engl. Transl.);* **8**: No. 2, 106-119(Mar 1977).

The present status of the study of fragmentation of nuclei by high-energy particles is reviewed.

STRONG MESON-INDUCED INTERACTIONS

REFER ALSO TO CITATION(S) 27100, 27119, 27132, 27226

27136 (BNL—23612) **New states below 2.2 GeV observed in e^+e^- annihilations.** Protopopescu, S.D. (Brookhaven National Lab., Upton, N.Y. (USA)). 1977. Contract EY-76-C-02-0016. 24p. (CONF-771089—4). Dep. NTIS, PC A02/MF A01.

From Particles and fields meeting; Argonne, IL, USA (6 Oct 1977).

From October 1976 to July 1977 data were taken at the new e^+e^- storage rings DCI at Orsay and at the ADONE e^+e^- storage rings at Frascati between 1.35 and 2.2 GeV. In these data there is evidence for possibly as many as 7 resonance states in that energy region. From DCI comes evidence for two relatively narrow I = 0 states, one near 1660 MeV with GAMMA approximately 25 MeV and the other near 1770 MeV with GAMMA approximately 50 MeV, and possibly two broad I = 1 states at 1540 and 1700 MeV both close to 200 MeV wide. From ADONE comes evidence for 3 narrow states: at 2130 MeV with GAMMA less than 50 MeV, at 1830 MeV with GAMMA less than or equal to 30 MeV and at 1498 with GAMMA less than or equal to 4 MeV.

27137 (SLAC-PUB—1998) **Recent results on new particle production at SPEAR.** Schwitters, R. (Stanford Linear Accelerator Center, Calif. (USA)). Aug 1977. Contract EY-76-S-03-0326. 31p. (CONF-770736—2). Dep. NTIS, PC A03/MF A01.

From INS international symposium on new particles and the structure of hadrons; Tokyo, Japan (12 Jul 1977).

Evidence for and properties of the charmed mesons D°, D/sup +-/, and their excited states is considered. Some very recent results on the structure of R, the ratio of the total cross section for hadron production by e^+e^- annihilation to the point-like muon pair cross section, in the center-of-mass energy region near 4 GeV are discussed. Evidence for D states, mass, spin, mixing, production cross sections, decay properties, and the observation of the psi (3772) are discussed. 38 references. (JFP)

27138 Comparison of K^{+-}N charge-exchange reactions at 8.5 and 13 GeV/c. Gilchriese, M.G.D.; Dunwoodie, W.; Fieguth, T.; Hutchinson, D.P.; Johnson, W.B.; Kunz, P.F.; Lasinski, T.A.; Leith, D.W.G.S.; Meyer, W.T.; Ratcliff, B.N.; Schacht, P.; Shapiro, S.; Williams, S.H.; Marshall, M.; Scheid, J.; Chien, C.; Madansky, L.; Pevsner, A.; Woody, C.; Zdanis, R.A. (Stanford Linear Accelerator Center, Stanford University, Stanford, California 94305). *Phys. Rev. Lett.;* **40**: No. 1, 6-9(2 Jan 1978).

The cross sections for the line-reversed reaction pairs $K^+n \rightarrow K^0p$ and $K^-p \rightarrow$ K-bar^{0}n, and $K^+p \rightarrow K^0\Delta^{++}$ and $K^-n \rightarrow$ K-bar$^0\Delta^-$ have been determined with high statistics and good relative normalization at 8.36 and 12.8 GeV/c in a spectrometer experiment at Stanford Linear Accelerator Center. The cross sections for the K^+-induced reactions are larger than for the K^-, contrary to the expectations of weakly-exchange-degenerate Regge-pole models. The ratio of the reaction cross sections is about the same as at lower energies and shows little change with momentum transfer.

27139 Comparison of inclusive charged-pion production in π^{+-}p interactions at 100 GeV/c. Whitmore, J.; Oh, B.Y.; Pratap, M.; Sionakides, G.; Smith, G.A.; Barnes, V.E.; Carmony, D.D.; Christian, R.S.; Garfinkel, A.F.; Morse, W.M.; Rangan, L.K.; Voyvodic, L.; Walker, R.; Anderson, E.W.; Crawley, H.B.; Firestone, A.; Kernan, W.J.; Parker, D.L.; Glasser, R.G.; Hill, D.G.; Kazuno, M.; McClellan, G.; Price, H.L.; Sechi-Zorn, B.; Snow, G.A.; Svreck, F.; Erwin, A.R.; Harvey, E.H.; Loveless, R.J.; Thompson, M.A. (Department of Physics, Michigan State University, East Lansing, Michigan 48824). *Phys. Rev., D;* **16**: No. 11, 3137-3149(1 Dec 1977).

Inclusive single-particle spectra for π^{+-} production are presented for data from π^{+-}p interactions at 100 GeVc. The spectra for the four reactions π^{+-}p $^{+-}$ anything are compared as a function of laboratory longitudinal momentum, Feynman x center-of-mass (c.m.) rapidity, and transverse momentum squared. Comparisons are also made between these data and analogous data from 16 and 18.5 GeV/c π^{+-} interactions and the energy dependence is discussed. Average values of the transverse momentum are given as a function of the longitudinal momentum and charged-particle multiplicity. A comparison of the charge distributions is presented as a function of rapidity and c.m. energy.

27140 Search for Ξ^* production in K^-p interactions at 2.87 GeV/c. Briefel, E.; Gourevitch, S.A.; Kirsch, L.; Schmidt, P.; Chang, C.Y.; Hemingway, R.J.; Khoury, B.V.; Stottlemyer, A.R.; Yodh, G.B.; Fernow, R.C.; Glickman, S.L.; Goldberg, M.; Jacobs, S.M.; Meadows, B.T.; Moneti, G.C.; Weygand, D.P.; Tompkins, J.; Canter, J.; Katsoufis, E.; Mann, W.A.; Schneps, J.; Wolsky, G. (Brandeis University, Waltham, Massachusetts 02154). *Phys. Rev., D;* **16**: No. 9, 2706-2726(1 Nov 1977).

Evidence is presented for production of Ξ^* resonances, decaying into $\Xi\pi$, Ξ (1530) π, ΛK-bar, and ΣK-bar, in K^-p interactions at 2.87 GeV/c. The data represent final combined results from a 30-events/μb hydrogen exposure and an 18-events/μb exposure in deuterium designed to study Ξ^* production in the mass interval 1.46—2.07 GeV/c^2. In addition to Ξ (1820) and Ξ (1940), signals have been observed at masses of 1630 MeV/c^2 and 1860 MeV/c^2 decaying into $\Xi^-\pi^+$ and YK-bar, respectively. Reaction cross sections have been measured for all final states containing two visible signs of strangeness, and for the final states ΛK^-K^+ and $\Sigma^0K^-K^+$.

27141 Search for π^+p → D-bar$^0C_1^{++}$ near threshold. Goddard, M.C.; Gilbert, D.; Key, A.W.; Gordon, H.A.; Lai, K.W. (Department of Physics, University of Toronto, Toronto, Canada M5S 1A7). *Phys. Rev., D;* **16**: No. 9, 2730-2732(1 Nov 1977).

We have established an upper limit of 2.6 μb on the cross section times branching ratio for π^+p → D-bar$^0C_1^{++}$ at a center-of-mass energy of 4.51 GeV. An upper limit of 1.4 μb is quoted for π^+p → D-bar$^0C_1^{++}$, C_1^{++} → $C_0^+\pi^+$. We estimate that the D-bar$^0C_1^{++}$ decay modes investigated are 15 % of the total combined hadronic decays.

27142 Cross sections and polarizations in the reactions π^-p → ΛK^0 and π^-p → ΛK^{*0}(890) near the backward direction, from 3 to 6 GeV/c. Ward, C.E.W.; Ambats, I.; Lesnik, A.; Meyer, W.T.; Musgrave, B.; Phelan, J.J.; Rest, J.; Rust, D.R.; Yovanovitch, D.D.; Yuta, H. (High Energy Physics Division, Argonne National Laboratory, Argonne, Illinois 60439). *Phys. Rev., D;* **16**: No. 7, 2041-2053(1 Oct 1977).

We have measured the differential cross sections and Λ polarizations in the reactions π^-p → ΛK^0 and π^-p → ΛK^{*0}(890) near the backward direction, at 3, 4, 5, and 6 GeV/c. Data equal to several times the world's total sample above 2 GeV/c were recorded. Both reactins are characterized by cross sections falling rapidly with beam momentum, and by large positive Λ polarizations for u' between 0.0 and 0.6 GeV^2. Analysis of π^-p → ΛK^0 yields an effective Regge trajectory consistent with antishrinkage of the backward peak. Separation into amplitudes of definite-parity-naturality exchange shows the reaction to be dominated by unnatural-parity exchange. The energy behavior of this exchange is, however, not consistent with a single linear baryon Regge trajectory or exchange-degenerate pair of trajectories. An apparent normalization discrepancy between data on π^-p → ΛK^0 of a CERN-ETH group and other high-statistics data including that of this experiment is discussed.

27143 Study of the reactions π^-p → $\pi^+\pi^-$n and π^-p → K^+K^-n at 1.98 and 2.41 GeV/c. Leeper, R.J.; Buttram, M.; Crawley, H.B.; Duke, D.W.; Lamb, R.C.; Peterson, F.C. (Sandia Laboratories, Albuquerque, New Mexico 87115). *Phys. Rev., D;* **16**: No. 7, 2054-2072(1 Oct 1977).

We have studied the reactions π^-p → $\pi^+\pi^-$n and π^-p → K^+K^-n at 1.98 and 2.41 GeV/c over a dimeson mass range from 0.75 to 1.23 GeV/c^2. Final-state neutrons were detected near 0^0 corresponding to vertical-bart - t/sub min/vertical-bar < 0.003 (GeV/c)^2 near a dimeson mass of 1.0 GeV/c^2. Charged particles were detected in the Argonne Effective Mass Spectrometer and/or scintillation detectors surrounding the hydrogen target. The mass of the dimeson was calculated from the beam and neutron four-vectors, the latter being determined by the measured flight time of the neutrons, with a mass resolution of σ = 4 MeV/c^2. One of the prominent features of the $\pi^+\pi^-$ mass spectrum is a sharp break near 0.95 GeV/c^2. This feature and the rapid rise of the K^+K^- spectrum near threshold are analyzed in terms of the parameters of the S* resonance. In the kinematic region covered by our data the contribution of the rho meson is small. The 62 000 $\pi^+\pi^-$ events (11 000 three-constraint and 51 000 one-constraint) and the 470 K^+K^- events (all four-constraint) were analyzed with both a Breit-Wigner and a K-matrix formulation with various parameterizations of the background. Consistent values of the S* pole parameters were obtained in all of the various types of analyses for both beam momenta. An average of the parameters from these fits gives the position of the S* pole to be (969 +- 5) - i (15 +- 4) MeV/c^2, compared to the present world average of (993.2 +- 4.4) - i (20.0 +- 3.7) MeV/c^2.

27144 Study of final states in π^-N → $\mu^+\mu^-$ + hadrons at 225 GeV. Jonckheere, A.M.; Cook, V.; Csorna, S.; Holmgren, D.; Lubatti, H.J.; Malecki, P.; Moriyasu, K.; Robinson, B.; Fournier, D.; Heusse, P.; Veillet, J.J.; Klems, J.H.; Ko, W.; Lander, R.L.; Pellett, D.E. (Department of Physics, University of Washington, Seattle, Washington 98195). *Phys. Rev., D;* **16**: No. 7, 2073-2082(1 Oct 1977).

An investigation is made of the final-state hadrons produced in association with muons by a 225-GeV π^- beam interacting with a Lucite target. It is found that the hadrons produced in association with muon pairs do not differ significantly from hadrons produced in any other inelastic interaction. Cross sections for psi/J production in Lucite and Pb and upper limits for charmed-particle production are obtained. A comparison is made with models of psi/J production.

27145 Inclusive production of neutral strange particles in 250-GeV/c π^-p interactions. Bogert, D.; Hanft, R.; Harris, R.; Huson, F.R.; Kahn, S.; Pascaud, C.; Smart, W.M.; Albright, J.R.; Hagopian, S.; Hays, P.; Lannutti, J.E. (Fermi National Accelerator Laboratory, Batavia, Illinois 60510). *Phys. Rev., D;* **16**: No. 7, 2098-2103(1 Oct 1977).

Neutral-strange-particle production has been studied in a 46 000-picture exposure in the Fermilab 15-ft bubble chamber. Cross sections for inclusive production of K^0/sub S/, Λ, and Lambda-bar are given and compared with data at lower energies. The K^0/sub S/'s are produced principally in the central region of rapidity with a cross section which increases with energy. The Λ's are produced principally by proton fragmentation, whereas the Lambda-bar's are centrally produced. Correlations of K^0/sub S/π^+ and K^0/sub S/K^0/sub S/ are shown to be different from those for $\pi^-\pi^+$.

PARTICLE INTERACTIONS AND PROPERTIES - THEORETICAL

GENERAL

REFER ALSO TO CITATION(S) 27279, 27291, 27309

27146 (COO—3130TA-340) **Progress report for a research program in theoretical high-energy physics.** Feldman, D.; Fried, H.M.; Guralnik, G.S.; Kang, K.; Tan, C.I. (Brown Univ., Providence, R.I. (USA). Dept. of Physics). 1 Oct 1977. Contract EY-76-C-02-3130. 15p. Dep. NTIS, PC A02/MF A01.

Last year's research program dealt with a variety of topics including hadron dynamics (Pomeron interaction in the eikonal approximation, estimates of all eikonal pionization graphs, study of the critical behavior in Reggeon field theory, status of Regge pole models in KN scattering); phenomenology of renormalizable gauge theory (tests of flavor mixing, dimuon events, SU(3) gauge model with unmixed quarks, lepton models, CP violation, neutrino magnetic moment); spectral sum rules (axial-vector masses, mixing angles); application of the self-consistent field approximation to relativistic quantum field theory; topics in gravitation and cosmology; as well as other studies involving elementary particle interactions. A list of publications is included. (JFP)

27147 (LBL—6597) **Nuclear collisions at very high energy.** Glendenning, N.K. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). 31 Aug 1977. Contract W-7405-ENG-48. 31p. (CONF-770995—1). Dep. NTIS, PC A03/MF A01.

From Symposium on future accelerators; Bombay, India (19 Sep 1977).

The treatment of very high energy nuclear reactions covers the equation of state and energy thresholds, two classes of high energy nucleus—nucleus collisions, the kinetics of a central collision, elementary particles, and the possible determination of the hadronic mass spectrum by high energy nuclear collisions. 15 references. (JFP)

27148 Newly found resonance Y (9.5) and the charge of the heavy quark. Hagiwara, T.; Kazama, Y.; Takasugi, E. (The Rockefeller University, New York, New York 10021). *Phys. Rev. Lett.;* **40**: No. 2, 76-80(9 Jan 1978).

The newly discovered resonance Y (9.5) is studied as a bound state of a heavy quark and its antiquark. From the estimate of the production cross section, it is argued that the charge of the constituent quark is likely to be -1/3.

27149 New absolutely stable hadrons. Cahn, R.N. (Physics Department, University of Michigan, Ann Arbor, Michigan 48109). *Phys. Rev. Lett.;* **40**: No. 2, 80-83(9 Jan 1978).

Observed universality among the known quarks and leptons requires that additional quarks be mixed little, or not at all, with the four conventional quarks. Discrete symmetries can result in the latter possibility and give rise to absolutely stable (pseudoscalar) hadrons. These particles would produce remarkable β decays, x-ray spectra, and hypernuclei.

27150 Is an electron's charge independent of its velocity. Bartlett, D.F.; Ward, B.F.L. (Princeton University, Princeton, New Jersey 08540). *Phys. Rev., D;* **16**: No. 12, 3453-3458(15 Dec 1977).

We hypothesize that a particle's charge varies weakly with its velocity. Specifically, suppose that the charge of a slow electron (or proton) varies as $q = e\,(1 + kv^2/c^2)$, where k very-much-less-than 1. This hypothesis can be tested for conduction electrons by rotating a current-carrying solenoid inside a Faraday ice pail. Alternatively a block of metal may be cooled inside an ice pail. Using either of these two techniques we find $k < 10^{-6}$. For free electrons, we use electron beam measurements of others to determine that $k < 0.2$. Finally a limit of $k < 2 \times 10^{-15}$ is inferred for bound electrons from existing data on the neutrality of various atoms.

27151 Natural stepwise breaking of gauge and discrete symmetries. Georgi, H.; Pais, A. (Lyman Laboratory of Physics, Harvard University, Cambridge, Massachusetts 02139). *Phys. Rev., D;* **16**: No. 12, 3520-3527(15 Dec 1977).

We ask if it is possible for spontaneous symmetry breakdown to occur stepwise. The presence of massless non-Goldstone bosons in the tree approximation is necessary both for the continuous case (gauge hierarchies involving "pseudophotons") and for the discrete case, but it is not sufficient. Our findings on additional constraints are presented in the form of theorems. The first (concerning pseudophotons) depends only on the validity of perturbative expansions and on the Goldstone theorem. The other two require that all massless non-Goldstone bosons in the tree approximation arise from a vacuum symmetry.

27152 Semiclassical infrared emission processes in the $(phi^4)_4$ theory. Chang, S.; Yao, Y.; Karliner, I. (Fermi National Accelerator Laboratory, Batavia, Illinois 60510). *Phys. Rev., D;* **16**: No. 12, 3541-3547(15 Dec 1977).

We consider the decay of a timelike gluon into soft gluons in a $(phi^4)_4$ theory. We make a semiclassical approximation by keeping only the diagonal tree diagrams. We are able to determine the dominant features of the soft-gluon emissions by examining the decay amplitude in the position space. We have obtained the asymptotic decay rate, the average multiplicity, and moments of the multiplicity for the final gluons. In particular, we find that in the strong-coupling limit all the energy of the original timelike gluon is turned into emission of soft gluons at rest.

27153 Relativistic eikonal expansion. Wallace, S.J.; McNeil, J.A. (Department of Physics and Astronomy, University of Maryland, College Park, Maryland 20742). *Phys. Rev., D;* **16**: No. 12, 3565-3580(15 Dec 1977).

The generalized ladder series of Feynman diagrams for scattering of two particles by scalar-meson exchange is expanded, using functional methods, to obtain the relativistic eikonal approximation and the next two terms of an expansion about the eikonal limit. The established similarity between nonrelativistic and relativistic eikonal approximations is shown to persist, in part, to the higher-order terms in the relativistic eikonal expansion. The leading-order correction to the eikonal limit differs only kinematically from its nonrelativistic counterpart. In second order, there is again much similarity with nonrelativistic results; however, a part of the second-order eikonal correction explicitly depends on the relative time coordinate of the scattering particles. An approximate relativistic Schroedinger equation is found to reproduce the leading corrections to the eikonal limit by means of a simple kinematic generalization of the nonrelativistic potential theory results; however, the relativistic time effect cannot be readily incorporated into a three-dimensional wave equation.

27154 Solutions to a gauge-invariant, equal-time two-body wave equation. Light-mass quark-antiquark system. Geffen, D.A.; Suura, H. (University of Minnesota, School of Physics and Astronomy, Minneapolis, Minnesota 55455). *Phys. Rev., D;* **16**: No. 11, 3305-3319(1 Dec 1977).

We study systematically the equal-time relativistic equation with a confinement potential, its boundary conditions, and the resulting bag-type solutions and eigenvalues. We show that the flux is continuous across the bag boundary. The chiral symmetry of the equation for vanishing quark masses is spontaneously broken for J = 0 states because of the boundary condition. We take a model potential consisting of a linear potential and a modified Coulomb potential that vanishes at the origin and show that the Nambu-Goldstone condition on the π meson can be implemented, and that the known I = 1 meson spectrum can be accounted for with remarkable success, provided the Coulomb coupling constant g^2 is chosen above the critical value 2.

27155 Nonperturbative approach to infrared behavior for $(phi^3)_6$ theory and a mechanism of confinement. Chang, S.; Yao, Y. (Department of Physics, University of Illinois at Urbana-Champaign, Urbana, Illinois 61801). *Phys. Rev., D;* **16**: No. 10, 2948-2966(15 Nov 1977).

We consider the inclusive probability for a timelike virtual scalar gluon in massless $(phi^3)_6$ theory (an asymptotically free theory) to dissociate into an arbitrary number of gluons. This quantity is also the imaginary part of the gluon propagator. Our approach is nonperturbative and the results bound the tree approximation from below. Among other things, we find that (1) the leading-ln-sum method yields a result similar to its counterpart in non-Abelian gauge theory but is in fact erroneous and uninteresting for deducing infrared behavior, (2) the origin of the coupling-constant plane is singular, and (3) the true infrared behavior is such that, as the cutoff is removed, the quantity calculated diverges faster than any power. It is further noted that in the strong-coupling limit the soft gluons due to cascading consume all the original energy. This is a strong indication that hard gluons cannot be dynamically excited, which in turn may be a mechanism for hard-gluon confinement.

27156 Singular pseudoparticles in Higgs theories. Henyey, F.S.; Patrascioiu, A. (Department of Physics, B-019, University of California, San Diego, La Jolla, California 92093). *Phys. Rev., D;* **16**: No. 10, 3021-3025(15 Nov 1977).

We present a new class of pseudoparticles in four-dimensional Euclidean non-Abelian gauge theories with Higgs fields. These pseudoparticles, in the classical limit, have nonzero Lagrangian density at only one single point. We discuss the topological and analytic construction of these pseudoparticles and the related fractional-topological-charge configurations. The action of a unit-topological-charge pseudoparticle is the usual $8\pi^2/g^2$. These pseudoparticles are not field configurations, but are limiting cases of field configurations. Owing to quantum fluctuations, their size is proportional to $\sqrt{h}$ if h is small.

27157 Generalization of the quark-confining string. Ng, Y.J.; Tye, S.H. (Stanford Linear Accelerator Center, Stanford University, Stanford, California 94305). *Phys. Rev., D;* **16**: No. 8, 2468-2475(15 Oct 1977).

It is natural to generalize the quark-confining string model by introducing additional terms coming from the Riemann curvature tensor. For simplicity, only terms linear in the Riemann tensor are considered. In the absence of quark fields, such terms are trivial (as in two-dimensional gravity). In the presence of quark fields, embedding of the string in four-dimensional Minkowski space renders such terms nontrivial. We formulate this generalized quark-confining string in the first-order form, from which we derive its second-order form. The coupling between the quark spin and the string curvature via the connections induces a spin-spin interaction among the quark fields. This generalized version has a dimensionless parameter κ in addition to the quark-gluon coupling e and quark masses. The original version is recovered as a special case (i.e., $\kappa = 0$).

27158 Pseudoparticles and massless fermions in two dimensions. Callan, C.G. Jr.; Dashen, R.; Gross, D.J. (The Institute for Advanced Study, Princeton, New Jersey 08540). *Phys. Rev., D;* **16**: No. 8, 2526-2534(15 Oct 1977).

The role of pseudoparticles in the breakdown of chiral U(N) symmetry is studied in a two-dimensional model. Chiral U(1) is always destroyed by the axial-vector anomaly. For N = 2 chiral SU(N) is also spontaneously broken yielding massive fermions and three (decoupled) Goldstone bosons. For N > or = 3 the fermions remain massless. Realistic four-dimensional theories are believed to behave in a similar way but the critical N above which the fermions cease to be massive is not known in four dimensions.

27159 Retention of quantum numbers by quark and multiquark jets. Brodsky, S.J.; Weiss, N. (Stanford Linear Accelerator Center, Stanford University, Stanford, California 94305). *Phys. Rev., D;* **16**: No. 7, 2325-2335(1 Oct 1977).

Quantum-number retention in the fragmentation region of a jet is investigated as a means to identify and classify quark and multiquark systems in lepton- and hadron-induced reactions. We show that a simple "inside-outside" cascade model with a causal space-time structure predicts that the mean charge of hadrons in the jet fragmentation region equals the charge of the parent quark system modulo a universal constant eta/sub Q/ (the mean quark charge of the sea) confirming previous analyses. Specific tests are discussed, including deep-inelastic neutrino scattering, e^+e^- annihilation with a strongly leading hadron, and massive-lepton-pair produc-

tion. We emphasize that the Drell-Yan process could play a crucial role in testing these ideas for multiquark jets and identifying a possible "hole" fragmentation region. We also discuss the utility of using a charge-momentum vector as a discriminant of jet structure. Finally we emphasize the utility of charge-retention tests in large-p/ sub T/ hadronic reactions in order to discriminate between various contributing subprocesses.

27160 Quark confinement and field theory. Stump, D.R.; Weingarten, D.H. (eds.). New York; John Wiley and Sons (1977). 260p. (CONF-7606132—). .

From Symposium on quark binding; Rochester, NY, USA (14 Jun 1976).

Separate abstracts were prepared for the 12 papers presented. (JFP)

27161 Is there a signal of quark confinement from perturbation theory. Poggio, E.C. (Harvard Univ., Cambridge, MA). pp 93-106 of Quark confinement and field theory. Stump, D.R.; Weingarten, D.H. (eds.). New York; John Wiley and Sons (1977).

From Symposium on quark binding; Rochester, NY, USA (14 Jun 1976).

See CONF-7606132—.

The question of whether the presence of the large infrared logarithms affects in any sense the determination of physical amplitudes involving quarks and gluons is considered in a report of results from previous investigations. Global impressions of their nature and of what they mean as far as the confinement issue is concerned. A comparison is made with analogous quantum electrodynamic processes, where the corresponding infrared aspects are completely understood. Quark form factor behavior, quark-antiquark scattering, the weak and the strong KLN theorems, and perturbation theory and confinement are treated. 26 references. (JFP)

27162 Currents, quarks, and gluons. Mohapatra, R.N. (City Coll., New York). pp 145-164 of Quark confinement and field theory. Stump, D.R.; Weingarten, D.H. (eds.). New York; John Wiley and Sons (1977).

From Symposium on quark binding; Rochester, NY, USA (14 Jun 1976).

See CONF-7606132—.

An attempt is made to argue that, contrary to the prevailing belief, if one assumes that color gluons mediating strong interactions are massive (and thus, color is an observable degree of freedom), then interesting restrictions on the type of unifying gauge groups one can use to unify weak, strong, and electromagnetic coupling constants and the number of flavor degrees of freedom can arise. The consequences of this hypothesis for high energy neutrino experiments, for low color thresholds, are discussed, and it is demonstrated that the rise observed in charged-current neutrino interactions at high energies can indeed be explained without the need for any new currents. 66 references. (JFP)

27163 Charmonium. Yan, T.M. (Cornell Univ., Ithaca, NY). pp 165-188 of Quark confinement and field theory. Stump, D.R.; Weingarten, D.H. (eds.). New York; John Wiley and Sons (1977).

From Symposium on quark binding; Rochester, NY, USA (14 Jun 1976).

See CONF-7606132—.

The treatment of charmonium covers naive charmonium and coupling to decay channels. The energy shifts due to virtual decay, the renormalized bound state spectrum, the strong modification of the ^{3}P/sub J/ and PSI states by decay, radiative rates, and the parameter R are examined. 51 references. (JFP)

27164 More freedom now: an explanation of local duality and other mysteries. Politzer, H.D. (Harvard Univ., Cambridge, MA). pp 233-253 of Quark confinement and field theory. Stump, D.R.; Weingarten, D.H. (eds.). New York; John Wiley and Sons (1977).

From Symposium on quark binding; Rochester, NY, USA (14 Jun 1976).

See CONF-7606132—.

Unambiguous predictions of asymptotic freedom for 1 less than or approximately Q^2 less than or approximately 15 GeV^2 electroproduction are described and confirmed by the data. The logarithms of asymptotic freedom are observed; their scale determines the quark-gluon coupling to be small, but nonzero: g^2 (2 GeV)/$4\pi^2$ approximately 0.15. Local duality and a refined version of the Drell-Yan relation emerge from the field theory. A prediction for R(= sigma/sub L//sigma/sub T/) disagrees with current experiment.

27165 Quarks. Buccella, F. (Univ., Rome). pp 459-463 of Weak and electromagnetic interactions at high energies. Part A. Levy, M.; Basdevant, J.L.; Speiser, D.; Gastmans, R. (eds.). New York; Plenum Press (1976).

From Proceedings of weak and electromagnetic interactions at high energies; Cargese, France (30 Jun 1975).

See CONF-7506176—P1.

The concept of the quark from the last fifteen years of research is considered. Particle multiplets, quantum numbers, and the color model are discussed. 33 references. (JFP)

27166 Relativistic composite systems and extensible models of fields and particles. Barut, A.O. (Univ. of Colorado, Boulder). pp 323-343 of Mathematical physics and physical mathematics. Maurin, K.; Raczka, R. (eds.). Boston; D. Reidel Publishing Co. (1976).

From Symposium on mathematical physics and physical mathematics; Warsaw, Poland (25 Mar 1975).

See CONF-740395—.

Extended models of elementary particles are considered under the following topics: relativistic description of extended structures, an extensible field (ether), the electromagnetic string and extended singularities of the electromagnetic field, pulsating electromagnetic sphere, passage to Hamiltonian formalism--quantization, the role of diffeomorphisms of extensible objects in quantization, and passage to dynamical groups and infinite-component wave equations. It is remarked that the proton shows considerable structure when probed by electrons and neutrinos, but no constituents have been identified so far; it is stated that a truly extended model of the proton would solve the puzzle immediately--the extended structure does not need to have further constituents. 2 figures, 1 table. (RWR)

27167 Short review of methods used to compute bound states. Guenin, M. (Univ., Geneva). pp 401-417 of Mathematical physics and physical mathematics. Maurin, K.; Raczka, R. (eds.). Boston; D. Reidel Publishing Co. (1976).

From Symposium on mathematical physics and physical mathematics; Warsaw, Poland (25 Mar 1975).

See CONF-740395—.

A brief review is given on various methods for the discussion and computation of the properties of bound states of particles. Attention is focused on questions of principles; there is no interest in numerical computations. Characteristics of the "bound-state" problem are presented. Then two major approaches to the solution are examined: the equivalent or effective potential approaches and the Bethe—Salpeter type of equations. Although both approaches have had a certain amount of success, both are far from being satisfactory answers to the bound-state problem. 121 references. (RWR)

ELECTROMAGNETIC INTERACTIONS

REFER ALSO TO CITATION(S) 27200, 27207, 27212, 27213, 27292, 27294, 27295

27168 (PB—270968) **Electromagnetic interactions from 5 to 500 MeV and nuclear research: a position paper as of March 1977. Final report.** Maximon, L.C. (National Bureau of Standards, Boulder, Colo. (USA). Inst. for Basic Standards). Aug 1977. 55p. (NBS-TN—955). NTIS PC A04/MF A01.

The author presents the current status of both experimental measurements and theoretical expressions for cross sections for the majority of the electromagnetic processes that are intimately connected with nuclear research using electromagnetic probes, emphasizing in particular those theoretical papers which are both reliable and useful for an analysis of the experiments, and indicating those regions in which the theoretical calculations are inadequate. Serving as a structure for this presentation, four areas of experimental research have been chosen, and we discuss in reasonable detail the status of the latest experiments in these areas: total photoabsorption cross section measurements, elastic photon scattering and Delbruck scattering, electron scattering and its corrections-radiative, recoil, dispersive and relativistic: and the bremsstrahlung spectrum tip. In addition, a guide to the more pertinent articles (experiment and theory) on the subject of virtual photons is presented.

27169 (SLAC-PUB—1613) **Deep inelastic electron and muon scattering.** Taylor, R.E. (Stanford Linear Accelerator Center, Calif. (USA)). Jul 1975. Contract EY-76-S-03-0326. 45p. (CONF-750654—60). Dep. NTIS, PC A03/MF A01.

From High energy particle physics divisional conference of EPS; Palermo, Italy (23 Jun 1975).

From the review of deep inelastic electron and muon scattering it is concluded that the puzzle of deep inelastic scattering versus annihilation was replaced with the challenge of the new particles, that the evidence for the simplest quark-algebra models of deep inelastic processes is weaker than a year ago. Definite evidence of scale breaking was found but the specific form of that scale breaking is difficult to extract from the data. 59 references. (JFP)

27170 (SLAC-PUB—1643) **e^+e^- interactions.** Lynch, H.L. (Stanford Linear Accelerator Center, Calif. (USA)). Aug 1975. Contract EY-76-S-03-0326. 70p. Dep. NTIS, PC A04/MF A01.

The total cross sections for hadron production and scale invariance as applied to e^+e^- annihilation are discussed. Also the narrow psi resonances at 3.095 and 3.684 GeV are also considered. General properties as well as specific decay modes are discussed. A definitive review is not given in these lectures. 46 references. (JFP)

27171 (SLAC-PUB—1814) **e^+e^- hadron production and jet structure at SPEAR.** Hanson, G.G. (Stanford Linear Accelerator Center, Calif. (USA)). Sep 1976. Contract EY-76-S-03-0376. 36p. (CONF-760672—4; CONF-760719—39). Dep. NTIS, PC A03/MF A01.

From 7. international colloquium on multiparticle reactions; Tutzing, F.R. Germany (21 Jun 1976).

Results on the total cross section for production of multihadronic events and inclusive distributions of the hadrons from e^+e^- annihilation in the center-of-mass energy range from 2.4 to 7.8 GeV are presented. Evidence for jet structure in the multihadronic events and the angular distributions of the hadrons and of the jet axis are reported. Inclusive distributions of hadrons in Feynman x, transverse momentum, and rapidity relative to the jet axis are presented.

27172 **Clean tests of quantum chromodynamics in μp scattering.** Georgi, H.; Politzer, H.D. (Lyman Laboratory of Physics, Harvard University, Cambridge, Massachusetts 02138). *Phys. Rev. Lett.;* **40**: No. 1, 3-6(2 Jan 1978).

Hard gluon bremsstrahlung in μp scattering produces final-state hadrons with a large component of momentum transverse to the virtual-photon direction. Quantum chromodynamics can be used to predict not only the absolute value of the transverse momentum, but also its angular distribution relative to the muon scattering plane. The angular correlations should be insensitive to nonperturbative effects.

27173 **Contribution to the eighth-order anomalous magnetic moment of the muon.** Chlouber, C.; Samuel, M.A. (Quantum Theoretical Research Group, Department of Physics, Oklahoma State University, Stillwater, Oklahoma 74074). *Phys. Rev., D;* **16**: No. 12, 3596-3601(15 Dec 1977).

The eighth-order contribution to the muon anomaly from second-order vacuum polarization insertions into photon-photon scattering diagrams is accurately determined. The result is a/sub μ/(8)($\gamma\gamma$) = (117.4 +- 0.5)(α/π)^4. The coefficients of the ln^2(m/sub μ//sub /me-italic/) and ln(m/sub μ//sub /me-italic/) terms are also evaluated. The coefficient of ln^2(m/sub μ//sub /me-italic/) is found to be just one half the value expected from naive application of renormalization-group methods, and it is shown how this arises.

27174 **Can couplings of charged heavy leptons to the W^0 be measured.** Budny, R.; McDonald, A. (Rockefeller University, New York, New York 10021). *Phys. Rev., D;* **16**: No. 11, 3150-3156(1 Dec 1977).

We consider effects of the W^0 on the one-particle inclusive distribution for the reaction $e^+e^- \rightarrow L^+L^- \rightarrow (l\nu\text{nu-bar})(sX)$, where the energy and/or angle of l are observed, and s is any specific state detected along with l as the signature of the L^+L^- pair, and discuss the possibility of deducing W^0 couplings from measurements.

27175 **Neutral-current effects in Bethe-Heitler pair production.** Mikaelian, K.O.; Oakes, R.J. (Fermi National Accelerator Laboratory, Batavia, Illinois 60510). *Phys. Rev., D;* **16**: No. 11, 3216-3224(1 Dec 1977).

We consider Bethe-Heitler pair production in which the exchanged photon is replaced with a neutral weak intermediate boson. The interference between this and the pure Bethe-Heitler amplitudes contributes to an asymmetry between the lepton pairs and, in addition, the leptons acquire a finite longitudinal polarization. Both effects are calculated and numerical examples are given in the standard Weinberg-Salam model.

27176 **Jet structure in e^+e^- annihilation as a test of quantum chromodynamics and the quark-confining string.** DeGrand, T.A.; Ng, Y.J.; Tye, S.H. (Stanford Linear Accelerator Center, Stanford University, Stanford, California 94305). *Phys. Rev., D;* **16**: No. 11, 3251-3270(1 Dec 1977).

We examine the jet structure in e^+e^- annihilation from two processes: (a) the bremsstrahlung of a hard gluon and (b) the emission of a meson at wide angle via the constituent-interchange model (CIM). At center-of-mass energies from 12 to 25 GeV, both processes, if present, are found to broaden the sharp transverse-momentum damping of jets observed at SPEAR. At lower energies and large transverse momentum we find that the CIM process prevails. But by center-of-mass energies greater than 30 GeV the gluonic process should be dominant. We also examine the jet structure generated by the decay of a bound state of new heavy quarks into three gluons. Should such quarks (m/sub q/ $>$ or $\approx$ 5 GeV) exist, this bound state would provide an ideal place to look for gluon-induced jets. Other topics we have studied include (i) jet structure via the production of four quarks and (ii) different possible gluonic fragmentation functions. Jet structure in deep-inelastic lepton-hadron scattering processes is also briefly considered. We conclude that e^+e^- annihilation is probably the cleanest place to search for gluonic structure, whose existence would be striking evidence in favor of quantum chromodynamics (QCD). On the other hand, the absence of such structure would necessitate a reexamination of our intuitive understanding of QCD and a serious consideration of other field-theoretical hadronic models, e.g., the quark-confining string, which, unlike QCD, does not possess gluonic degrees of freedom.

27177 **Corrections to the two-gluon annihilation rates of paracharmonium states.** Suaya, R.; Townsend, J. (Department of Physics, McGill University, Montreal, Quebec H3C 3G1, Canada). *Phys. Rev., D;* **16**: No. 11, 3346-3348(1 Dec 1977).

The effect of a color anomalous magnetic moment and of the finite size of the charmonium system on the annihilation rate of paracharmonium into two gluons is considered. Although these effects can reduce this rate by a factor of 2 from its lowest-order value, there remains a large discrepancy for one of these states between the theoretical and experimental values.

27178 **Radiative decays of fermions and the mass of the photon.** Goldman, T.; Macrae, K.I. (Theoretical Division, Los Alamos Scientific Laboratory, University of California, Los Alamos, New Mexico 87545). *Phys. Rev., D;* **16**: No. 9, 2830-2832(1 Nov 1977).

We show that the current experimental limit on the mass of the photon implies an extremely weak coupling strength if the decay fermion $\rightarrow$ fermion$'$ + photon proceeds by a gauge-invariance-violating, charge-like coupling as opposed to the usually assumed gauge-invariant magnetic coupling.

27179 **etaeta$'$ and ωphi mixing in the nonrelativistic quark model.** Borchardt, S.R.; Mathur, V.S. (Physics Department, Syracuse University, Syracuse, New York 13210). *Phys. Rev., D;* **16**: No. 7, 2245-2250(1 Oct 1977).

We investigate meson electromagnetic decays in the nonrelativistic quark model (NRQM) and find support for a nonstandard etaeta$'$ mixing recently suggested by strong-interaction analysis. We also find evidence that such mixing may also describe the ωphi system and conclude furthermore that the NRQM gives a good account of such processes when this new mixing is used.

27180 **Differential dispersive analysis of e^+e^- annihilation into hadrons.** Ward, B.F.L. (Stanford Linear Accelerator Center, Calif. (USA)). *Lett. Nuovo Cim.;* **19**: No. 12, 469-473(23 Jul 1977).

By means of the natural differential dispersive character of the renormalization group, a possible explanation of the present high energy data for e^+e^- hadrons in the region away from psi/J, psi$'$, is given.

27181 **Photoproduction of J/psi mesons in the peripheral model. The direct peripheral mechanism.** Boreskov, K.G.; Ioffe, B.L. (Institute of Theoretical and Experimental Physics, State Atomic Energy Commission). *Sov. J. Nucl. Phys. (Engl. Transl.);* **25**: No. 4, 429-433(Apr 1977).

An analysis is made of the direct (non-diffractive) peripheral mechanism for the photoproduction of J/psi mesons, in which the amplitude for the process is determined by the exchange of non-Reggeized mesons. Exchanges of pseudoscalar and axial-vector mesons are considered. The experimentally observed energy dependence of the cross section for J/psi photoproduction can be reproduced only in the case of axial-vector meson exchange. In this case, the main contributions to the total photoproduction cross section and to dσ/dt for E/sub γ/GeV come from inelastic processes $\gamma N \rightarrow$psiX with m/sub X/9 or $\approx$2 GeV.

27182 **Geometry and interactions of instantons.** Wilczek, F. (Princeton Univ., NJ). pp 211-219 of Quark confinement and field theory. Stump, D.R.; Weingarten, D.H. (eds.). New York; John Wiley and Sons (1977).

From Symposium on quark binding; Rochester, NY, USA (14 Jun 1976).

See CONF-7606132—.

Some work on classical gauge fields is summarized. First it is shown how Riemannian geometry structures lead to SO(4) gauge structures, and give some applications of this idea. Second, it is shown how the existence of inequivalent embeddings of SU(2) in larger groups has some remarkable implications for the interactions of instantons (and monopoles).

27183 **Phenomenology of electron positron annihilation into hadrons.** Nachtmann, O. (Univ., Bern). pp 219-264 of Weak and electromagnetic interactions at high energies. Part A. Levy, M.; Basdevant, J.L.; Speiser, D.; Gastmans, R. (eds.). New York; Plenum Press (1976).

From Proceedings of weak and electromagnetic interactions at high energies; Cargese, France (30 Jun 1975).

See CONF-7506176—P1.

The discussion of the phenomenology of electron-positron annihilation into hadrons covers the total cross section including production and decay of Psi particles, the addition of further quarks, and thawing the color degree of freedom. Also included are the final states considering decays of the psi(3100) and psi(3700), and scaling in inclusive spectra. 40 references. (JFP)

WEAK INTERACTIONS

REFER ALSO TO CITATION(S) 27255, 27292, 27390

27184 (SLAC-PUB—1891) **Search for heavy particles.** Barnett, R.M. (Stanford Linear Accelerator Center, Calif. (USA)). Mar 1977. Contract EY-76-S-03-0376. 44p. (CONF-770124—8). Dep. NTIS, PC A03/MF A01.

From Conference of the Orbis Scientiae Center for Theoretical Studies; Coral Gables, FL, USA (16 Jan 1977).

Direct and indirect evidence for the existence of a new heavy quark b and of new heavy neutral leptons N/sub e/ and N/sub μ/ can be sought in neutrino and e^+e^- scattering. These particles are expected to have right-handed currents. Discussion is given on the characteristics, production and decay of hadrons such as bb, ub and db, and of the massive neutral leptons. Muon number violation with and without N/sub e/ and N/sub μ/ is considered.

27185 **Interpretation of the Y (9.5) as evidence for another quark.** Lichtenberg, D.B.; Wills, J.G.; Kiehl, J.T. (Department of Physics, Indiana University, Bloomington, Indiana 47401). *Phys. Rev. Lett.;* **39**: No. 25, 1592-1594(19 Dec 1977).

We interpret the broad dimuon resonance at 9.5 GeV as two or three unresolved narrow states of a b quark and antiquark. We calculate the energy spectrum of bb-bar states using a linear plus one-gluon-exchange potential.

27186 **Quantum chromodynamics predictions for the associated production of charm by neutrinos.** Goldberg, H. (Stanford University Accelerator Center, Stanford University, Stanford, California 94305). *Phys. Rev. Lett.;* **39**: No. 25, 1598-1601(19 Dec 1977).

Cross sections for the inclusive production of charm-anti-charm pairs in the hadron showers of neutrino scattering are calculated within framework of quantum chromodynamics. A branching ratio of less than 10^{-3}, insufficient to account for the like-sign dimuons observed by Barish et al., Benvenuti et al., and Holder et al. and trimuons observed by Barish et al., and Benvenuti et al., is obtained for α/sub s/ = 0.4 at values of x between 0.05 and 0.3, and $\nu \sim$ 50—75 GeV.

27187 **Dimuon distribution from production of heavy particles in high-energy ν and nu-bar reactions.** Chang, L.N.; Ng, J.N. (Department of Physics, University of Pennsylvania, Philadelphia, Pennsylvania 19174). *Phys. Rev., D;* **16**: No. 11, 3157-3169(1 Dec 1977).

Dimuon distributions from the production of heavy particles in ν- and -ν-bar-induced reactions are obtained within the framework of the quark-parton model. General qualitative features independent of the model are pointed out. Available data are consistent with the production of at least one particle, of mass 1.8 GeV/c^2, in ν-induced reactions, with ordinary (V-A) currents, and perhaps one more heavier particle, of mass around 3.5 GeV/c^2 to 4.5 GeV/c^2, with (V + A) currents, in nu-bar-induced reactions. Methods for determining production probability functions from dimuon distributions are pointed out.

27188 **Lifetimes and branching ratios for heavy-lepton cascades.** Barger, V.; Gottschalk, T.; Nanopoulos, D.V.; Phillips, R.J.N. (University of Wisconsin, Physics Department, Madison, Wisconsin 53706). *Phys. Rev., D;* **16**: No. 11, 3170-3176(1 Dec 1977).

We have advocated a heavy-lepton model in which the muonic sector M^-,M^0 explains neutrino-produced trimuons via cascade decay, and the electronic sector E^-,E^0 accounts for $e^+e^- \rightarrow \mu e$ + (missing energy) events. For these heavy leptons we estimate lifetimes, expected track lengths in bubble-chamber and emulsion experiments, and branching ratios for all decay stages.

27189 **Like-sign muon-electron production by neutrinos: Key to trilepton mechanisms.** Barger, V.; Gottschalk, T.; Nanopoulos, D.V.; Phillips, R.J.N. (University of Wisconsin, Physics Department, Madison, Wisconsin 53706). *Phys. Rev., D;* **16**: No. 11, 3177-3181(1 Dec 1977).

The most promising explanations of $\nu N \rightarrow \mu^-\mu^- X$ and $\nu N \rightarrow \mu^- e^- X$ like-sign dilepton events are two classes of models that have recently been proposed to explain neutrino trimuon production: (i) cascade decay of a charged heavy lepton M^-, (ii) decay of a neutral heavy lepton M^0 together with semileptonic decay of a new quark b. These two classes predict quite different lepton energies for $\nu N \rightarrow \mu^- e^- X$ events. They also predict completely different charge topologies for antineutrino-produced trileptons and like-sign dileptons.

27190 **Electron signals from heavy-lepton cascade decays.** Albright, C.H.; Smith, J.; Vermaseren, J.A.M. (Department of Physics, Northern Illinois University, DeKalb, Illinois 60115). *Phys. Rev., D;* **16**: No. 11, 3204-3215(1 Dec 1977).

The heavy-lepton-cascade interpretation of neutrino-induced multimuon events also yields events with electrons which can be identified in bubble-chamber experiments. We study processes giving rise to single-electron events, dilepton $\mu^- e^+$,$\mu^- e^-$ events, and trilepton $\mu\mu e$, $\mu e e$ events. Rates are presented for different quark transitions. We give results for distributions and also discuss the background reaction ν/sub e/ + $N \rightarrow e^- + X$ caused by contamination of the muon-type neutrino beam by electron-type neutrinos.

27191 **Weak radiative decays of baryons in SU(4).** Mahanthappa, K.T.; Unger, D.G. (Department of Applied Mathematics and Theoretical Physics, University of Cambridge, Cambridge, CB3 9EW, England). *Phys. Rev., D;* **16**: No. 11, 3284-3292(1 Dec 1977).

Various sum rules for the weak radiative decay amplitudes of charmed and charm-zero baryons are derived in the framework of SU(3) and SU(4) with and without octet/sextet and 20 dominance, respectively. The effects of the inclusion of the right-handed currents and short-distance contributions are discussed.

27192 **Charmed-meson decay in the massive-quark model.** Mathur, V.S.; Rizzo, T. (Department of Physics and Astronomy, University of Rochester, Rochester, New York 14627). *Phys. Rev., D;* **16**: No. 11, 3343-3345(1 Dec 1977).

Charmed-pseudoscalar-meson decays are discussed in a quark model with massive quarks. In particular, we show that the semileptonic branching ratios for the decays can be sizable, as suggested by the dimuon data.

27193 **Neutral heavy leptons and e^+e^- colliding—beam experiments.** Humpert, B.; Scharbach, P.N. (Stanford Linear Accelerator Center, Stanford University, Stanford, California 94305). *Phys. Rev., D;* **16**: No. 9, 2754-2764(1 Nov 1977).

The possibilities for detecting neutral heavy leptons N^0 in e^+e^- annihilation experiments are investigated. A detailed study of the important N^0 decay modes is presented. The kinematical features of the reactions $e^+e^- \rightarrow N^0$N-bar^0 and nu-barN^0 with subsequent decay $N^0 \rightarrow e\pi$ are explored with a view to deducing the heavy-lepton couplings.

27194 **Distinguishing scaling violations from new currents.** Barnett, R.M.; Martin, F. (Stanford Linear Accelerator Center, Stanford University, Stanford, California 94305). *Phys. Rev., D;* **16**: No. 9, 2765-2768(1 Nov 1977).

Controversy exists over explanation of anomalies in antineutrino scattering. We argue that the alternatives, scaling violations or new currents, can be measured separately. Scaling violation also plays a crucial role in dilepton production, one of the best tests of b-quark production. We conclude with a discussion of the role of scaling violation in neutral-current neutrino scattering.

27195 **Cascade decays of heavy leptons produced by neutrinos.** Barger, V.; Gottschalk, T.; Nanopoulos, D.V.; Abad, J.; Phillips, R.J.N. (Physics Department, University of Wisconsin, Madison, Wisconsin 53706). *Phys. Rev., D;* **16**: No. 7, 2141-2157(1 Oct 1977).

Gauge models with two heavy leptons that decay sequentially are proposed as a mechanism for fast multilepton production by neutrinos. To quantify the predictions of such models, a specific SU(2) x U(1) model is constructed and realistic calculations are made of the heavy-lepton production and decay sequence: $\nu N \rightarrow M^- X$, $M^- \rightarrow M^0 l^-{}_1 \nu$-bar, $M^0 \rightarrow l^-{}_2 l^+{}_3 \nu$. Good agreement with trimuon data is found, with masses 7 GeV for M^- and 2—4 GeV for M^0. The information contained in experimental distributions of multilepton events is explored. Azimuth-momentum correlations exclude a hadron-vertex origin for the extra muons in $\mu^-\mu^-\mu^+$ and in some $\mu^-\mu^+$ events. The two undetected decay neutrinos carry off missing energy equal to 35% of the visible energy on the average; this prediction can be tested with narrow-band beams. The cascade mechanism gives rise to $\mu^-\mu^-$ and $\mu^-\mu^+$ events at about five times the $\mu^-\mu^-\mu^+$ rate. The observed trimuon rate may require a mixing of μ/sub L/$^-$ with M/sub L/$^-$ comparable to the Cabibbo angle, which strains conventional universality limits. A generalized mixing scheme which circumvents these limits and allows large ν/sub μ// sub hyphenM-/ coupling is presented.

27196 **Analysis of weak-interaction effects in high-transverse-momentum hadron-hadron collisions.** Fischbach, E.; Look, G.W. (Physics Department, Purdue University, West Lafayette, Indiana 47907). *Phys. Rev., D;* **16**: No. 7, 2199-2218(1 Oct 1977).

Parity-violating (pv) weak effects in inclusive hadron-hadron scattering processes such as $pp \rightarrow \pi^+ X$ and $pp \rightarrow \Lambda X$ are studied in the framework of the parton model. Such effects arise from the coherent interference of the strong and weak parton-parton scattering amplitudes, and manifest themselves experimentally through a difference in the cross sections for protons incident with initial +- helicity, or through a longitudinal polarization of the outgoing Λ produced by an unpolarized beam. Results for the corresponding pv parameters A and P are presented assuming a variety of weak-interaction models. For the strong parton-parton interaction we use the recently introduced effective-gluon model. A detailed discussion is given of phases in the weak and strong interactions and of the strong-weak relative phase in various models. It is shown that both vertical-barAvertical-bar and vertical-barPvertical-bar increase with increasing $\sqrt{s}$ and x/sub perpendicular tsts2pperpendicular/$/\sqrt{s}$, where $\sqrt{s}$ is the center-of-momentum energy and p/sub perpendicu-

lar/is the transverse momentum of the inclusively produced π^+ or Λ. For $\sqrt{s}$ = 20 GeV and x/sub perpendicular/vertical-barAvertical-bar and vertical-barPvertical-bar can be as large as 10^{-3}—10^{-4} in some models, which may make such effects detectable in future experiments. In other models A and P can actually vanish identically for certain values of $\sqrt{s}$ and x/sub perpendicular/due to cancellations among the individual quark contributions. It is noted that, for a given weak-interaction model, the dependence of A and P on x/sub perpendicular/and $\sqrt{s}$ is different in the effective-gluon and constituent-interchange models, and hence weak effects can be used to discriminate among models of the strong interaction. A discussion is also given of various experimental problems associated with measuring A and P.

27197 Limits on the mass of the muon neutrino in the absence of muon-lepton-number conservation. Goldman, T.; Stephenson, G.J. Jr. (Theoretical Division, Los Alamos Scientific Laboratory, University of California, Los Alamos, New Mexico 87545). *Phys. Rev., D;* **16**: No. 7, 2256-2259(1 Oct 1977).

We show that muon neutrinos of masses greater than 10^{-2}, 6, or 25 keV (depending upon the particular class of theories) may decay in less than the lifetime of the universe in wide classes of weak-interaction theories which violate separate muon-lepton-number conservation. We conclude that the astrophysical limit of Cowsik and McClelland on the mass of light neutral particles cannot be applied to the muon neutrino in the absence of experimental limits on its mass at these values.

27198 Flavor conservation in an SU(3) x U(1) x U(1) model. Wyler, D. (Physics Department, Carnegie-Mellon University, Pittsburgh, Pennsylvania 15213). *Phys. Rev., D;* **16**: No. 7, 2289-2294(1 Oct 1977).

We discuss natural flavor conservation of the weak neutral current in a theory with non-Abelian neutral subgroups in the example of an SU(3) x U(1) x U(1) structure. It is only possible to suppress flavor-changing neutral currents in the manner of Glashow and Weinberg if stable heavy particles exist.

27199 Simple symmetry breaking in a chiral SU(4) x SU(4) model of pseudoscalar mesons. Singer, M. (Physics Department, University of Wisconsin, Madison, Wisconsin 53706). *Phys. Rev., D;* **16**: No. 7, 2304-2312(1 Oct 1977).

We calculate the effects of simple symmetry breaking on the mass spectrum, neutral isoscalar mixing angles, and decays of pseudoscalar mesons using a chiral SU(4) nonlinear model to describe the mesons. We find that in addition to quark-mass-type terms, a simple U(1) -breaking term will induce a reasonable isoscalar mass spectrum, give a low value for the eta′ → eta$\pi\pi$ decay, and is the dominant contribution to the eta″ (paracharmonium) decay into three isoscalars. We also calculate the effects of symmetry breaking on hadronic currents and thus on the weak decays of new mesons.

27200 Implications of a nonzero neutrino mass for the process $\gamma\gamma \rightarrow \nu$nu-bar. Fischbach, E.; Rosen, S.P.; Spivack, H.; Gruenwald, J.T.; Halprin, A.; Kayser, B. (Physics Department, Purdue University, West Lafayette, Indiana 47907). *Phys. Rev., D;* **16**: No. 7, 2377-2378(1 Oct 1977).

Recent considerations relating to neutrino oscillations and to the decay $\mu \rightarrow e\gamma$ suggest that neutrinos may acquire a small but nonzero mass. The process $\gamma\gamma \rightarrow \pi^0 \rightarrow \nu$nu-bar could then proceed via either an induced S,P coupling arising from a primitive V,A neutrino current or via a fundamental S,P neutrino coupling. Although the resulting $\gamma\gamma \rightarrow \pi^0 \rightarrow \nu$nu-bar cross section would, in the former case, be suppressed by a factor of order (m/sub ν//sub /mπ/)^2, this process could, nonetheless, be of interest in astrophysical processes in a temperature region where the pion pole is significant.

27201 Violation of scaling and the production of charmed particles in neutrino experiments. Gershtein, S.S.; Folomeshkin, V.N. (Institute of High Energy Physics, Serpukhov). *Sov. J. Nucl. Phys. (Engl. Transl.);* **25**: No. 4, 441-446(Apr 1977).

It is shown that the charge asymmetry in the structure functions for deep inelastic scattering of neutrinos (antineutrinos) by nucleons can be explained as a consequence of charmed-particle production in the sea of strange quarks if the sea of charmed quarks is suppressed. Using the known experimental values of the parameters of deep inelastic scattering and a value of about 10% for the relative probability of the lepton decay modes, a result is obtained for the cross section for charmed-particle production which is in agreement with the experimental yields of lepton pairs. The model provides a satisfactory description of all the kinematic characteristics of lepton pair production. It is shown that an enhancement of the quark-antiquark sea implied by the data on charged currents has an appreciable effect on the cross section for processes induced by neutral currents (particularly for antineutrino interactions).

27202 Quantum mechanics in particle physics. Boehm, A. (Univ. of Texas, Austin). pp 345-360 of Mathematical physics and physical mathematics. Maurin, K.; Raczka, R. (eds.). Boston; D. Reidel Publishing Co. (1976).

From Symposium on mathematical physics and physical mathematics; Warsaw, Poland (25 Mar 1975).

See CONF-740395—.

The question of whether and to what extent relativistic quantum mechanics can describe the structure of hadrons in principally the same way as nonrelativistic quantum mechanics describes the structure of atoms is addressed: in particular, whether the mass levels of the hadrons and other properties of one-hadron states like decay rates and form factors can be calculated in analogy to energy levels and transition rates for atoms is considered. The example of the leptonic and semileptonic decay of the K meson is used, and the decay of hadron states is treated in some detail rather than the hadron spectrum. A value of 0.283 is obtained for the suppresion factor; the experimental value is 0.224. The quantum-mechanical description given here may in principle be used for every weak and electromagnetic decay process that involves transitions between hadrons that can be considered as different states of one and the same hadron system. (RWR)

27203 Composite gauge fields and models. Budini, P. (International Centre for Theoretical Physics, Trieste, Italy); Furlan, P. pp 361-399 of Mathematical physics and physical mathematics. Maurin, K.; Raczka, R. (eds.). Boston; D. Reidel Publishing Co. (1976).

From Symposium on mathematical physics and physical mathematics; Warsaw, Poland (25 Mar 1975).

See CONF-740395—.

After a phenomenological study of the possibility of the existence of massless composite lepton and antilepton states originated by the lepton weak interaction Lagrangian, it is concluded that only one such composite state could exist and be strongly coupled in a unique way to the free left-handed leptons and that its quantum numbers could only be those of the photon (j = 1,0; PI C = +1, -1). In the frame of the unified gauge models with a lower limit for the W meson mass, a condition for its existence is that the W mass be of the order of 100 GeV. It is then shown that the composite massless field has the properties of a gauge field, and its gauge transformations are deduced from those of the constituent spinor fields as a consequence of the Wilson expansion of the products of the constituent two-component canonical spinor fields. This property also applies to the case when the two-component spinor fields build up a degenerate multiplet and the corresponding gauge group is nonabelian. The gauge fields of unified models of weak and electromagnetic interactions could then be considered as composite, with the possibility of computing some of the parameters, such as the coupling constant of the gauge fields, which are otherwise free in these models, and with the advantage of eliminating the infinities of the triangular diagrams. Parity-conserving quantum electrodynamics is obtained with a method analogous to that used in the unified gauge models; it is finite, and its regularizing length is of the order of magnitude of the square root of the Fermi coupling constant. An example of application to the Salam—Weinberg model is given, together with a rough estimate of sin theta. The possibility of a bootstrap mechanism and a dynamical symmetry breaking a la Nambu—Jona—Lasinio to substitute the Higgs mechanism is mentioned. Finally, some possibilities are suggested to explain dynamically the universality of charge quantization.

27204 Super-gauge groups. Fronsdal, C. (Univ., Trieste, Italy). pp 475-481 of Mathematical physics and physical mathematics. Maurin, K.; Raczka, R. (eds.). Boston; D. Reidel Publishing Co. (1976).

From Symposium on mathematical physics and physical mathematics; Warsaw, Poland (25 Mar 1975).

See CONF-740395—.

Some spinorial transformation groups are studied by methods due to Salam and Strathdee [Nucl. Phys., B76: 477 (1974)]; these groups transform bosons into fermions and vice versa. A super-field wave equation that conforms to the Fierz—Pauli principle is given by use of chiral spinor variables. Neutrino gauge transformations are defined in close analogy with electromagnetic gauge transformations, and a minimal principle for interactions with neutrinos is proposed.

STRONG INTERACTIONS, GENERAL

REFER ALSO TO CITATION(S) 27255

27205 (SLAC-PUB—2009) **Large transverse momentum phenomena.** Brodsky, S.J. (Stanford Linear Accelerator Center, Calif. (USA)). Sep 1977. Contract EY-76-S-03-0326. 23p. (CONF-770697—3). Dep. NTIS, PC A02/MF A01.

From 8. international symposium on multi-particle dynamics; Kaysersberg, France (12 Jun 1977).

It is pointed out that it is particularly significant that the quantum numbers of the leading particles are strongly correlated with the quantum numbers of the incident hadrons indicating that

the valence quarks themselves are transferred to large p/sub t/. The crucial question is how they get there. Various hadron reactions are discussed covering the structure of exclusive reactions, inclusive reactions, normalization of inclusive cross sections, charge correlations, and jet production at large transverse momentum. 46 references. (JFP)

27206 (SLAC-PUB—2020) **Quark confinement.** Drell, S.D. (Stanford Linear Accelerator Center, Calif. (USA)). Oct 1977. Contract EY-76-S-03-0326. 78p. Dep. NTIS, PC A05/MF A01.

The problem of "where are the quarks" is considered. Some theoretical efforts to understand the novel behavior of quark constituents in the hadron are described, explained, and analyzed. (JFP)

27207 (TID—28062) **Quark—quark interactions at the p anti p Collider.** Kernan, A. (California Univ., Riverside (USA)). 19 Sep 1977. 20p. Dep. NTIS, PC A02/MF A01.

Elucidation of the dynamics of hadron constituents will be one of the goals of the CERN p anti p Collider. Strong and electromagnetic interactions of constituents are considered within the framework of two models: quark-quark elastic scattering and quark-antiquark fusion. Possible backgrounds from these processes in W-boson searches are discussed.

27208 Disentangling the scattering matrix when there is a dominant reaction mechanism. Johnson, P.W.; Thomas, G.H. (Physics Department, Illinois Institute of Technology, Chicago, Illinois 60616). *Phys. Rev., D;* **16**: No. 9, 2783-2792(1 Nov 1977).

Our previous strategy for obtaining the S matrix from polarization measurements is applied to a general spin-1/2, two-body reaction at fixed s and t. One may test the hypothesis of a dominant reaction mechanism by carrying out a short list of M measurements: $M < \text{or} = 4$. Subdominant mechanisms may be extracted by a long list of 2N-2 measurements: N is the number of independent amplitudes and $N < \text{or} = 16$. The long list brings in all independent interferences of the dominant amplitude with the remaining amplitudes. The scale of the amplitudes is set by the differential cross section; the amplitudes can be determined only to within an overall phase. The cross section, short list, and long list are the elements of an optimal strategy for amplitude determination; its extension to arbitrary spins is discussed. These formal arguments do pay respect to practical aspects of amplitude determination.

27209 Generation of a Pomeron and an f Regge pole in the dual-unitarization program. Balazs, L.A.P. (Physics Department, Purdue University, West Lafayette, Indiana 47907). *Phys. Rev., D;* **16**: No. 9, 2905-2907(1 Nov 1977).

We discuss, within a simple SU(2) model which incorporates G parity, a self-consistent mechanism for simultaneously generating a Pomeron and an f. This involves going beyond the usual planar-cylinder-torus level. Complex Regge singularities, however, are also generated.

27210 Simple interpretation of the Reggeon cutting rules. Levin, E.M.; Ryskin, M.G. (Leningrad Institute of Nuclear Physics, USSR Academy of Sciences). *Sov. J. Nucl. Phys. (Engl. Transl.);* **25**: No. 4, 452-454(Apr 1977).

A clear physical interpretation of the Reggeon cutting rules of Abramovskii, Gribov, and Kancheli is presented. It clarifies the meaning of the ratios between the contributions of processes with different multiplicities to the total cross section for hadron interactions at high energies.

27211 Strings, vortices, and gauge fields. Nambu, Y. (Univ. of Chicago). pp 1-12 of Quark confinement and field theory. Stump, D.R.; Weingarten, D.H. (eds.). New York; John Wiley and Sons (1977).

From Symposium on quark binding; Rochester, NY, USA (14 Jun 1976).

See CONF-7606132—.

A few scattered observations are made on mathematical formalisms which are aimed at describing stringlike objects and their interactions. The attempt was originally motivated by the string model of hadrons, which may well be a phenomenological manifestation of a gauge theory of strong interactions. Emphasis is placed on broader aspects of the problem, keeping in mind that there may exist as yet unknown phenomena which are to be described by these mathematical formalisms. Of course it is sheer speculation at the moment. There are three main topics to be discussed. They are: relativistic hydrodynamics of vortices, its broken symmetry schemes and non-Abelian versions, and a unified algebraic characterization of string and gauge field equations.

27212 Gauge fields and strong interactions. Appelquist, T. (Yale Univ., New Haven). pp 191-218 of Weak and electromagnetic interactions at high energies. Part A. Levy, M.; Basdevant, J.L.; Speiser, D.; Gastmans, R. (eds.). New York; Plenum Press (1976).

From Proceedings of weak and electromagnetic interactions at high energies; Cargese, France (30 Jun 1975).

See CONF-7506176—P1.

These three lectures deal with several aspects of the Yang—Mills quark gluon theory of strong interactions. A dispassionate overview is followed by a plunge into the physics of electron positron annihilation into hadrons. Looming large in this discussion are the newly discovered, long-lived mesons. The role of these new heavy hadrons in the quark gluon model is examined. It is suggested that they are heavy quark antiquark bound states and that their properties could provide a rather clear and simple experimental handle on the underlying field theory.

27213 Hadrons (usual and newly discovered) in gauge theories a dream. Barbieri, R. (CERN, Geneva). pp 329-344 of Weak and electromagnetic interactions at high energies. Part A. Levy, M.; Basdevant, J.L.; Speiser, D.; Gastmans, R. (eds.). New York; Plenum Press (1976).

From Proceedings of weak and electromagnetic interactions at high energies; Cargese, France (30 Jun 1975).

See CONF-7506176—P1.

Emphasis is placed on questions: given the relative success of the description within the framework of a non-Abelian gauge field theory of the newly discovered phenomena in e^+e^- physics can one also learn something about usual hadrons in the same theoretical framework, and in particular is it possible to incorporate in the phenomenological scheme proposed for the new particles (charmonia) also the usual hadrons. Underlying field theory for strong interactions, the phenomenological scheme, specification of the full Hamiltonian, meson spectroscopy and its possible sources of corrections, meson decays, and e^+e^- annihilation at the charm threshold are also discussed. 15 references. (JFP)

27214 High transverse momentum hadron-hadron collisions. Bjorken, J.D. (Stanford Linear Accelerator Center, Calif. (USA)). *Acta Radiol., Diagn.;* **5**: No. 6, 893-906(1974).

From 14. Cracow school of theoretical physics; Zakopane, Poland (15 - 28 Jun 1974).

Some theoretical aspects of the subject of high-psub(transverse) hadron production in strong interactions are discussed. This includes properties of inclusive spectra, the parent-child relation and its applications to direct lepton and γ-ray production. Also discussed are hypotheses regarding the phase-space populations of associated particles, correlations and production of jets. Dynamical models are only very briefly discussed, and suggestions for future experimentation are listed.

STRONG INTERACTIONS, BARYON NO.=0

REFER ALSO TO CITATION(S) 27111, 27170

27215 (ANL-HEP-CP—77-81) **Comparison of anti p anti p and pp luminosities at Fermilab.** Diebold, R. (Argonne National Lab., Ill. (USA)). 1977. Contract W-31-109-ENG-38. 12p. Dep. NTIS, PC A02/MF A01.

The advantages of producing high luminosity anti pp and pp colliding beams are considered. Calculations of parameters of such beams and possible physical research using such beams are set forth. Eight references. (JFP)

27216 (SLAC-PUB—1774) **Baryon excitations in the bag model.** Jaffe, R.L. (Stanford Linear Accelerator Center, Calif. (USA); Massachusetts Inst. of Tech., Cambridge (USA). Lab. for Nuclear Science). Jul 1976. Contract EY-76-C-02-3069;EY-76-C-03-0515. 15p. (CONF-760729—8). Dep. NTIS, PC A02/MF A01.

From Topical conference on Baryon Resonances; Oxford, UK (5 Jul 1976).

Two recent spectroscopic applications of the bag model are discussed. The first is a study of the place of multiquark states in meson and baryon spectroscopy, and the second is an attempt to sort out the P-wave baryon excitations in a bag model. 33 references. (JFP)

27217 (SLAC-PUB—1980) **Progress in K spectroscopy.** Leith, D.W.G.S. (Stanford Linear Accelerator Center, Calif. (USA)). Jul 1977. Contract EY-76-S-03-0326. 30p. (CONF-770406—7). Dep. NTIS, PC A03/MF A01.

From 5. international conference on experimental meson spectroscopy; Boston, MA, USA (29 Apr 1977).

The progress in the field of K^* spectroscopy is reviewed within the framework of the simple harmonic oscillator quark model, and contrasted with the recent progress made in the charmonium spectroscopy.

27218 Consequences of quark-line (Okubo-Zweig-Iizuka) rule. Okubo, S. (Department of Physics and Astronomy, University of Rochester, Rochester, New York 14627). *Phys. Rev., D;* **16**: No. 7, 2336-2352(1 Oct 1977).

Consequences of the validity of the quark-line (Okubo-Zweig-Iizuka) rule have been studied both theoretically and experimentally. The present experimental data are consistent with the validity of the rule for 1^- and possibly 2^+ nonets. With respect to the 0^- nonet, the

rule is in reasonable agreement, if we consider a suitable mixing scheme for the eta-eta' complex. Theoretical implications of these facts are also discussed. The possible violation of the rule has been estimated to be 6% for the 1^- nonet and 15% for the 0^- nonet.

27219 Mesons from gluons. Kobzarov, N.Y.; Martem'yanov, V.B.; Shchepkin, M.G. (Institute of Theoretical and Experimental Physics). *JETP Lett. (USSR) (Engl. Transl.);* **25**: No. 12, 564-566(20 Jun 1977).

The mass of the meson (gluonium) that contains no quarks and consists of gluons only is calculated within the framework of the MIT bag model. We consider hadrons that contain valence gluons besides quarks.

27220 Hydrodynamic model of collective resonances in hadronic matter. Matveev, V.A. (Fermi National Accelerator Lab., Batavia, IL). pp 65-91 of Quark confinement and field theory. Stump, D.R.; Weingarten, D.H. (eds.). New York; John Wiley and Sons (1977).

From Symposium on quark binding; Rochester, NY, USA (14 Jun 1976).

See CONF-7606132—.

The collective resonance phenomena in multiquark hadronic systems is studied. The analysis is essentially qualitative and based on an analogy to the well known giant resonance phenomena in the nuclear matter. The nonrelativistic hydrodynamic equations are considered for a two-component compressible fluid describing a system of quarks and antiquarks confined to the interior of the finite volume. The confinement properties as well as the relevant phase transitions are discussed and the frequencies of the hydrodynamic oscillations of the system are derived. The problem of taking into account non-Abelian colored gluon fields in the hydrodynamic equations describing motion of confined quark/antiquark fluids ("chromo-hydrodynamics") is briefly discussed and the estimation of the effect of quark-gluon interactions on the energies of collective resonances is given. It is speculated that the collective resonances—or as we call them the hadronic giant resonances—may play an essential role in understanding the new resonances observed recently in e^+e^--annihilation and lepton pair production experiments in unexpectedly high mass intervals. Particularly, it is shown that the energies of the lowest hadronic giant resonances which could be seen in e^+e^--annihilation (EO and E2 modes) lie at approximately GeV if a size of the confinement region is about 1 GeV^{-1}(approximately 0.2 fm). One should expect also the existence of colored collective states with energies of about the same order as for uncolored ones, which cannot be seen however in the process of e^+e^- annihilation into hadrons due to the color conservation in strong interactions.

27221 Phenomenological model for charmed meson decay. Mathur, V.S. (Univ. of Rochester, NY). pp 189-202 of Quark confinement and field theory. Stump, D.R.; Weingarten, D.H. (eds.). New York; John Wiley and Sons (1977).

From Symposium on quark binding; Rochester, NY, USA (14 Jun 1976).

See CONF-7606132—.

The entire discussion of a phenomenological model for charmed meson decay is based on the validity of the simple GIM model of charm. The treatment consists of the model used, decay rates, and the $K^-\pi^+$ and $K^-3\pi^+$ decay modes. D and F resonances are considered. 33 references. (JFP)

27222 Influence of hadronic decay channels in confinement models of the new resonances. Eichten, E. (Cornell Univ., Ithaca, NY). pp 305-328 of Weak and electromagnetic interactions at high energies. Part A. Levy, M.; Basdevant, J.L.; Speiser, D.; Gastmans, R. (eds.). New York; Plenum Press (1976).

From Proceedings of weak and electromagnetic interactions at high energies; Cargese, France (30 Jun 1975).

See CONF-7506176—P1.

The consideration of the influence of hadronic decay channels in confinement models of the new resonances includes a review of the nonrelativistic potential model, shortcomings of the naive model, including hadronic decay channels, decay amplitudes for lowest order in W, obtaining the general solution, and the results of coupling to decay channels. 31 references. (JFP)

STRONG INTERACTIONS, BARYON NO.=1

REFER ALSO TO CITATION(S) 27216, 27220

27223 Kinematical enhancements due to pion diffraction dissociation into K anti K* and K anti *K: Spinless treatment. Pietilaeinen, E.P.; Lassila, K.E. (Ames Laboratory-ERDA and Department of Physics, Iowa State University, Ames, Iowa 50011). *Phys. Rev., D;* **16**: No. 9, 2803-2812(1 Nov 1977).

We study pion dissociation into K anti K* (or K anti*K) in $\pi p \rightarrow$ K anti K*p (or K anti*K) p at 16 GeV/c pion momentum, finding in multiperipheral-type models that a straightforward kinematical cut can be found to isolate the K* contribution to allow extraction of K*N scattering information. Here we use the spinless, Berger-type, Reggeized Deck model. We find that quantitative agreement with data follows in essentially parameter-free fashion for the cross section as a function of the K anti K* mass (including the sharp rise above M/sub K/ + M/sub K asterisk)/for the momentum-transfer slope dependence as a function of mass, for the partial-(angular momentum) wave amplitudes, and for the t-channel helicity-conservation characteristics of the data. The success of this straightforward approach suggests contributions of other 1^+ states coupled to the K anti K* channel are not dominant effects in the $\pi p \rightarrow$ K anti K*p (or anti K *p) reaction.

27224 Real parts of the pion-proton forward scattering amplitude. Engelmann, T.R.; Hendrick, R.E. (Carnegie-Mellon University, Pittsburgh, Pennsylvania 15213). *Phys. Rev., D;* **16**: No. 9, 2891-2896(1 Nov 1977).

The most recent total-cross-section data are used to calculate real parts of the forward elastic π^{+-}/sup p/scattering amplitudes from threshold to 240 GeV/c. Using statistical and systematic uncertainties of the total cross sections and their momenta, along with uncertainties of the subtraction and coupling constants, unphysical cuts, and cross-section extrapolations, we calculate the uncertainties of the real amplitudes. Our results are compared to experimental and other theoretical determinations of the π^{+-}/sup p/forward real amplitudes.

27225 Does the baryon spectrum reveal a diquark structure. Cutkosky, R.E.; Hendrick, R.E. (Carnegie-Mellon University, Pittsburgh, Pennsylvania 15213). *Phys. Rev., D;* **16**: No. 9, 2902-2904(1 Nov 1977).

We consider a model of baryons in which interactions among the quarks lead to a significant degree of diquark clustering. The model accommodates a low-lying $(56,1^-)$ multiplet and requires a low-lying $(70,0^+)$ multiplet.

STRONG INTERACTIONS, BARYON NO. GREATER THAN 1

REFER ALSO TO CITATION(S) 27215

27226 (COO—3069-556) **Review of hadron—nucleus interactions at high energy.** Halliwell, C. (Massachusetts Inst. of Tech., Cambridge (USA). Lab. for Nuclear Science). 1977. Contract EY-76-C-02-3069. 69p. (CONF-770697—2). NTIS, MF A01.

From 8. international symposium on multi-particle dynamics; Kaysersberg, France (12 Jun 1977).

Portions of document are illegible.

In this review an attempt is made to summarize briefly what is known experimentally and theoretically about hadron-nucleus collisions at high energies. Experimental techniques, multiparticle production, production of high transverse momenta secondaries, and the production of muon pairs. 11 references. (JFP)

27227 Dynamics of N-N total cross sections at medium energies. Kloet, W.M.; Silbar, R.R.; Aaron, R.; Amado, R.D. (Theoretical Division, Los Alamos Scientific Laboratory, University of California, Los Alamos, New Mexico 87545). *Phys. Rev. Lett.;* **39**: No. 26, 1643-1646(26 Dec 1977).

We show that a relativistic, one-pion-exchange, three-body theory including the (3,3) isobar and full spin dependence adequately describes the inelastic nucleon-nucleon cross section at energies where only single-pion production is important. Unitarization of the amplitude plays a significant role in obtaining the correct energy dependence. To fit elastic cross sections, however, will require inclusion of short-range potentials.

27228 Possibility of charmed hypernuclei. Dover, C.B.; Kahana, S.H. (Brookhaven National Laboratory, Upton, New York 11973). *Phys. Rev. Lett.;* **39**: No. 24, 1506-1509(12 Dec 1977).

We suggest that both two-body and many-body bound states of a charmed baryon and nucleons should exist. Estimates indicate binding in the $^1S_0$ state of C_1N (I = 3/2) and SN (I = 1). We further estimate the binding energy of C_0,C_1 various finite nuclei.

27229 Parton-picture unitary impact-parameter model for multicluster production. Chang, V.; Dean, N.W.; Lassila, K.E. (Ames Laboratory-ERDA and Department of Physics, Iowa State University, Ames, Iowa 50011). *Phys. Rev., D;* **16**: No. 11, 3271-3280(1 Dec 1977).

The multiperipheral parton model is used to develop a unitary impact-parameter model for multipion production in pp collisions. The interaction producing the pions through cluster emission is described by an "inelastic potential" if interpreted as a generalization from the eikonal Hamiltonian model or by an "inelastic structure function" if interpreted as a generalization from the Chou-Yang droplet model. This "inelastic potential" or "inelastic structure function" in terms of impact parameter is found to be constant for small-impact-parameter collisions, with a rapidly falling tail in the region of peripheral interactions near the nucleon radius. It is also shown that the constant part of this "inelastic potential" or "inelastic

structure function" is responsible for the central pionization products and that the falling-tail part is responsible for the diffractive fragmentation products. Quantitatively good comparison with pp production data from 50 to 400 GeV/c incident proton momentum is presented.

27230 Scattering of pions by deuterons at low and medium energies. Ferreira, E.M.; Rosa, L.P.; Thome, Z.D. (Stanford Linear Accelerator Center, Stanford University, Stanford, California 94305). *Phys. Rev., C;* **16**: No. 6, 2353-2366(Dec 1977).

We apply the multiple scattering method to calculate the differential cross sections for elastic πd scattering in the low and medium energy regions, showing the importance of the proper treatment of the kinematics in the two body collision. Our results are compared with all existing experimental data in these energy regions. We show that the large angle elastic scattering at medium energies is highly sensitive to details of the deuteron structure and of the calculation procedure, and provides an excellent ground to study the properties of the meson-deuteron and of the off-shell meson-nucleon interactions.

27231 Screening correction for hadron-deuteron absorption cross sections near 200 GeV/c. Lys, J.E.A. (Fermi National Accelerator Laboratory, Batavia, Illinois). *Phys. Rev., D;* **16**: No. 7, 2181-2183(1 Oct 1977).

We have determined the screening-correction factor G/sub a/ for proton-deuteron and positive-pion—deuteron absorption cross sections near 200 GeV/c. The determination uses measured cross sections on nucleon and deuteron targets, with an assumption about the one- and two-prong absorption cross sections on deuterons. The values found for G/sub a/ are larger than the corresponding total-cross-section screening-correction factors, but are in reasonable agreement with a simple geometrical prediction.

27232 Empirical formula for inclusive proton spectra between 10 and 300 GeV. Wang, C.L. (Brookhaven National Laboratory, Upton, New York 11973). *Phys. Rev., D;* **16**: No. 7, 2196-2198(1 Oct 1977).

An empirical formula which well represents the proton spectra in the inclusive reaction $p + Be \rightarrow p +$ anything between 10 and 300 GeV is constructed.

27233 Solar neutrinos and the role of exchange currents in the pp reaction. Andreev, Y.M.; Bugaev, E.V.; Kopysov, Y.S. (Nuclear Research Institute, USSR Academy of Sciences). *JETP Lett. (USSR) (Engl. Transl.);* **25**: No. 12, 557-560(20 Jun 1977).

It is shown that allowance for exchange mesic currents can increase the cross section of the pp reaction by a factor of two or more. Methods of experimentally verifying this possibility are discussed.

27234 Single W-meson production in the scattering of hadrons in the Coulomb field of nuclei. Grinchishin, Y.T. (Khar'kov State University). *Sov. J. Nucl. Phys. (Engl. Transl.);* **25**: No. 4, 437-441(Apr 1977).

For an arbitrary anomalous magnetic moment of the W meson, the total and differential cross sections for single W-boson production in the Coulomb field of the nucleus at high energies are calculated for the following reactions: $p+Z \rightarrow Z+W^{+}+n$ and π^{+-}/sup [Z → Z [W +- /+π^{0}. The total cross sections are of the order of 10^{-37}—10^{-38} cm² for light nuclei at $E \sim 10^{3}$ GeV and M/sub W/ ~ 10 GeV.

27235 Eikonal and quasi-eikonal models in the theory of complex angular momenta for pion elastic scattering and rho⁰-meson photoproduction on ⁴He nuclei. Grigoryan, L.A.; Shakhbazyan, V.A. (Erevan Physics Institute). *Sov. J. Nucl. Phys. (Engl. Transl.);* **25**: No. 4, 449-452(Apr 1977).

Formulas for pion elastic scattering from ⁴He nuclei are derived from the theory of complex angular momenta within the limitations of the eikonal and quasi-eikonal models. It is shown that shower enhancement effects, described by constant coefficients, effectively take into account the inelastic screening incident to rescattering from different nucleons of the target nucleus in the incident-particle energy range E/sub lab/=20—100 GeV. For both models the differential cross sections are very sensitive to the parameter values even at low squared momentum transfers in the range 0—0.3 $(GeV/c)^{2}$, this makes it possible to evaluate the parameters considerably more accurately than has yet been done. It is also shown that the same effects are present in rho⁰ photoproduction on ⁴He.

27236 Light antiprotonic atoms and quasinuclear mesons. Dal'karov, O.D.; Kerbikov, B.O.; Markushin, V.E. (Institute for Theoretical and Experimental Physics of the GKIAE). *Sov. J. Nucl. Phys. (Engl. Transl.);* **25**: No. 4, 455-461(Apr 1977).

The properties of p-anti- and p-anti-atoms formed in liquid hydrogen or deuterium are investigated. Various mechanisms for antiproton absorption from atomic states are discussed. A relation is established between the parameters of the antiproton cascade and the widths, binding energies, radii, and quantum numbers of quasinuclear mesons. It is shown that the existence of NN-bar states of a quasinuclear type allows one to explain the observed "anomalies" in the annihilations of stopped antiprotons in liquid hydrogen or deuterium.

27237 Possible mechanism of direct production of leptons in pN collisions. Volkov, G.G.; Nikitin, Y.P.; Sokolov, A.A. (Institute of High Energy Physics, Serpukhov). *Sov. J. Nucl. Phys. (Engl. Transl.);* **25**: No. 4, 470-472(Apr 1977).

A mechanism for the direct production of leptons in pN collisions is considered; it involves the cascade decay of a hypothetical hadron X^{+-} (charmon, colored hadron) according to the scheme $X^{+} \rightarrow M^{0}\mu^{+}$ (M^{0} is a heavy lepton), $M^{0} \rightarrow \mu^{-}\mu^{+}\nu$/sub $\mu/\mu^{-}e^{+}\nu$/sub e/, μ^{-} + a hadron via the weak V+A leptonic currents. The correct sign and value for the polarization of the "direct" muons are obtained. A qualitative explanation of the behavior of the "direct" lepton spectrum in the transverse momentum is given.

27238 Growth of the average multiplicity with increasing transverse momentum. Troshin, S.M. (Institute of High-Energy Physics, Serpukhov). *Sov. J. Nucl. Phys. (Engl. Transl.);* **25**: No. 4, 472-474(Apr 1977).

The dependence of the average multiplicity n on the transverse-momentum transfer is investigated. Within the limitations of the adopted model, which is based on the possibility of a probability interpretation of the unitarity condition, it is shown, under the assumption of weak correlations among the particles in the n-particle intermediate state, that n (s p/sub transverse/) increases linearly with the transverse momentum. The behavior of the average multiplicity as a function of the impact parameter is also investigated.

27239 Many-particle Regge poles in supersymmetric theory. Asatryan, G.M.; Matinyan, S.G.; Sedrakyan, A.G. (Yerevan Physics Institute). *Sov. J. Nucl. Phys. (Engl. Transl.);* **25**: No. 4, 475-478(Apr 1977).

The generation of the many-particle Regge poles found earlier is investigated using the supersymmetric Wess-Zumino model. It is shown that the conclusions of these studies on the quadratic dependence of the intercept of these poles on the number of particles in the t channel are also valid in supersymmetric theory.

PARTICLE INVARIANCE PRINCIPLES AND SYMMETRIES

GENERAL

REFER ALSO TO CITATION(S) 27151, 27297

27240 (SLAC-PUB—1974) **Three generations of quarks and leptons.** Harari, H. (Weizmann Inst. of Science, Rehovoth (Israel); Stanford Linear Accelerator Center, Calif. (USA)). Jul 1977. Contract EY-76-S-03-0326. 15p. (CONF-770406—6). Dep. NTIS, PC A02/MF A01.

From 5. international conference on experimental meson spectroscopy; Boston, MA, USA (29 Apr 1977).

The spectroscopy of quarks and leptons is reviewed with emphasis on weak transitions, mass patterns, right-handed currents, Cabibbo-like angles and the connection between quarks and leptons.

27241 Free field theories of spin-mass trajectories and quantum electrodynamics in the null plane. Bart, G.R.; Fenster, S. (Harry S. Truman College, Chicago, Illinois 60640). *Phys. Rev., D;* **16**: No. 12, 3554-3564(15 Dec 1977).

The ten generators of the Poincare algebra for quantum electroydnamics and other gauge field theories are given in the null plane such that they all explicitly correspond, in the free-field case, to the Bacry-Chang group-theoretic forms. The internal oscillator content is extracted for both gauge theories and dual resonance models. In contrast to manifestly covariant or other theories, Bacry-Chang—type generators have the advantages of not referring to dependent spin somponents and of being rational in the canonical variables. The last property implies a simple position-space representation. Since the forms are independent of spin magnitude and allow inclusion of charge quantum numbers at will, they seem to represent an advantageous free-particle starting point for a hadron field theory with positive spin-mass trajectories (SMT) and with interaction. The interaction terms from manifestly covariant theories are considered in the null plane and found to be cubic and quartic in the fields. A straightforward extension of these interactions to SMT has not been found. The dual model, however, encompasses SMT and is known to have interactions even though the full details of the model's interaction terms are not worked out here. Consequently, the approach indicates how a realistic spectrum might be achieved without composite hadrons and incorporating full Poincare invariance.

27242 Pseudoparticle parameters for arbitrary gauge groups. Bernard, C.W.; Christ, N.H.; Guth, A.H.; Weinberg, E.J. (Department of Physics, Columbia University, New York, New York 10027). *Phys. Rev., D;* **16**: No. 10, 2967-2977(15 Nov 1977).

The number of parameters entering a Euclidean Yang-Mills solution with topological charge k is determined for a theory constructed from an arbitrary Lie group G. It is shown that this number is precisely that required to specify the position, scale, and relative group orientation of k independent solutions each with minimum topological charge 1. Such minimal single-pseudoparticle solutions can be obtained by embedding the familiar SU_2 pseudoparticle of Belavin et al. into the general Lie group.

27243 Supercurrent anomaly in a supersymmetric gauge theory. Abbott, L.F.; Grisaru, M.T.; Schnitzer, H.J. (Department of Physics, Brandeis University, Waltham, Massachusetts 02154). *Phys. Rev., D;* **16**: No. 10, 2995-3001(15 Nov 1977).

It is demonstrated that an anomaly exists for the divergence of the supercurrent in a supersymmetric non-Abelian gauge theory. Since no gauge particle is coupled to the current, the anomaly does not alter the renormalizability of the theory. Some consequences of the anomaly are discussed.

27244 Possible supersymmetry breaking by pseudoparticles. Abbott, L.F.; Grisaru, M.T.; Schnitzer, H.J. (Department of Physics, Brandeis University, Waltham, Massachusetts 02154). *Phys. Rev., D;* **16**: No. 10, 3002-3007(15 Nov 1977).

The effects of pseudoparticles in a supersymmetric SU(2) gauge theory are discussed. The possibility of a nonperturbative breakdown of supersymmetry due to the pseudoparticles is suggested and explored, and the pseudoparticle contribution to the fermion 8-point function is explicitly calculated. Implications for supergravity and extended supergravity are briefly discussed.

27245 Chiral properties of the fermionic determinant in quantum chromodynamics. Hietarinta, J.; Palmer, W.F. (Department of Physics, The Ohio State University, Columbus, Ohio 43210). *Phys. Rev., D;* **16**: No. 10, 3008-3014(15 Nov 1977).

We study gauge-invariant Green's functions of quark-antiquark bilinear densities in massless, two-color quantum chromodynamics. We take into account nonzero-energy fermion modes, pseudoparticle solutions with topological charge $\nu > 1$, and n-point functions with $n > 2$. Some general properties of the O (h) approximation are developed, enabling us to isolate and define the terms which conbribute to a general n-point function. We find the higher effects preserve the symmetry breakdown found earlier in the 2-point function [U(2) x U(2) → SU(2) x SU(2) x U(1)].

27246 Internal symmetries and ghost symmetries. Domokos, G.; Koevesi-Domokos, S. (Department of Physics, Johns Hopkins University, Baltimore, Maryland 21218). *Phys. Rev., D;* **16**: No. 10, 3060-3067(15 Nov 1977).

A new approach to the problem of internal symmetries is suggested. We conjecture that broken internal symmetries of high order required by the quark phenomenology of high-energy processes correspond to certain noninvariance groups (ghost symmetries) arising as the result of an interplay between the dynamical and geometrical aspects of quark models. This conjecture is examined on the example of a theory possessing an SU(2) gauge symmetry. Fermion (quark) fields are constructed on the principal fiber bundle suitable for the geometrical description of this gauge model. The quark Lagrangian supports representations of unitary ghost-symmetry groups U(N); N is unbounded from above. Some qualitative consequences of such models are analyzed. In particular, we conjecture that certain quark selection rules arise as a consequence of a correspondence between internal symmetries and ghost-symmetry groups.

27247 CP violation, radiative symmetry-breaking effects, and Higgs-particle and fermion masses. McKay, D.W. (Stanford Linear Accelerator Center, Stanford University, Stanford, California 94305). *Phys. Rev., D;* **16**: No. 9, 2861-2873(1 Nov 1977).

Existence of CP violation is shown to require a bound on a Higgs-particle mass in several examples. A lower bound which depends on the fermion mass is derived from the one-loop approximation in an Abelian theory. Two SU(2) x U(1) examples are studied. The first produces radiative CP violation by electron and muon loops when a neutral-Higgs-particle mass is bounded by limits determined by electron and muon masses. The CP-violating vacuum phase θ is bounded by tanθ < or = 2(M/sub e//M/sub μ/)(M/sub e//M/sub μ/)2]. The usual four quarks couple to the two Higgs doublets as in the scheme proposed by Weinberg, and CP is violated by charged-Higgs-particle exchange. No third Higgs doublet is needed, but the bound on one neutral-Higgs-particle mass is so low that unacceptably large effects arise in thermal neutron-electron scattering. A second scheme with spontaneous P and CP violation by fermion loops, where heavy leptons and superheavy quarks are included, produces a light, neutral Higgs-particle mass which is estimated to be 300 MeV. Higgs-particle effects are within experimental limits. The vacuum phase angle θ is bounded by light-to-heavy-fermion mass ratios, M/sub f//M/sub f prime/according to tanθ < or = 2(M/sub f//M/sub f prime)/(M/sub f//M/sub f prime)/^{2}].

27248 Dynamical symmetry breakdown. Englert, F. (Univ., Brussels). pp 265-290 of Weak and electromagnetic interactions at high energies. Part A. Levy, M.; Basdevant, J.L.; Speiser, D.; Gastmans, R. (eds.). New York; Plenum Press (1976).

From Proceedings of weak and electromagnetic interactions at high energies; Cargese, France (30 Jun 1975).

See CONF-7506176—P1.

It is conjectured that minimal Lagrangians are physically relevant, and an attempt is made to trace the origin of masses back to dynamical spontaneous breakdown of chirality, scale invariance and possibly other symmetry groups. The term dynamical symmetry breakdown is reserved for such dynamical mass generation. A simple model for dynamical symmetry breakdown, the case g^2/sub V/ = g^2/sub A/ = g^2, dynamical symmetry breakdown for chiral groups, and the possible relevance to physics are considered. 35 references. (JFP)

27249 Simple mathematical models of symmetry breaking. Application to particle physics. Michel, L. (Institut des Hautes Etudes Scientifiques, Bures-sur-Yvette, France). pp 251-262 of Mathematical physics and physical mathematics. Maurin, K.; Raczka, R. (eds.). Boston; D. Reidel Publishing Co. (1976).

From Symposium on mathematical physics and physical mathematics; Warsaw, Poland (25 Mar 1975).

See CONF-740395—.

The meaning of "spontaneous broken symmetry" is explained first. Then two mathematical models of symmetry breaking are discussed: smooth action of a compact Lie group G on a manifold M and G-invariant algebras. Finally, application is made to particle physics. 1 figure, 39 references. (RWR)

APPLICATIONS TO ELECTROMAGNETIC AND WEAK INTERACTIONS

REFER ALSO TO CITATION(S) 27169, 27191, 27204

27250 Gauge theories of weak interactions with left-right symmetry and the structure of neutral currents. Mohapatra, R.N.; Sidhu, D.P. (Department of Physics, The City College of the City University of New York, New York, New York 10031). *Phys. Rev., D;* **16**: No. 9, 2843-2855(1 Nov 1977).

Failure to detect parity-violating effects in atomic transitions by Oxford and Washington groups would appear to rule out the Weinberg-Salam SU(2) x U(1) model as well as any variation of it that respects natural conservation laws for charm and strangeness to order a G/sub F/ (called "natural") and obeys quark-lepton symmetry. In this paper, a simple left-right—symmetric model based on the SU(2)/sub L/ x SU(2)/sub R/ x U(1) group with four and six quark flavors is analyzed and found to accomodate the results of the atomic experiments as well as the other features of neutral-current phenomena.

27251 Conditions for natural suppression of CP violation. Kim, J.E. (Department of Physics, Brown University, Providence, Rhode Island 02912). *Phys. Rev., D;* **16**: No. 9, 2856-2860(1 Nov 1977).

We study the conditions for the natural suppression of CP violation at the orders G/sub F/ and G/sub F/α of quark—gauge-boson couplings in the SU(2) x U(1) gauge-theory framework. For the natural suppression of CP at the order G/sub F/, the necessary and sufficient condition is that the quarks of the charges q and (a - 1) do not belong to the same isomultiplets for at least one chirality. However, it is not generally possible to naturally suppress CP at the order G/sub F/α except for the limited class of models such as the standard four-quark model.

27252 Tests of spontaneous left-right—symmetry breaking. Holstein, B.R.; Treiman, S.B. (Department of Physics and Astronomy, University of Massachusetts, Amherst, Massachusetts 01002). *Phys. Rev., D;* **16**: No. 7, 2369-2372(1 Oct 1977).

Experimental limits on the strength of right-handed (eν/sub e/) and ($\mu\nu$/sub μ/)current couplings are discussed in connection with a recent conjecture that parity nonconservation arises from spontaneous breaking of left-right symmetry.

27253 Broken gauge and scale invariance. O'Raifeartaigh, L. (Dublin Inst. for Advanced Studies). pp 431-440 of Mathematical physics and physical mathematics. Maurin, K.; Raczka, R. (eds.). Boston; D. Reidel Publishing Co. (1976).

From Symposium on mathematical physics and physical mathematics; Warsaw, Poland (25 Mar 1975).

See CONF-740395—.

Important developments that have taken place recently in the related fields of unified gauge theory (UGT) and renormalization group theory (RGT) are considered. The general idea in both UGT and RGT is to start from a limit in which there are no (or only trivial) masses, exploit the symmetry of that limit, and then introduce the masses as a form of symmetry breaking. Most recent progress has been in the area of taking and then breaking the symmetric limit. Essentially, this work gives the Einstein—Schroedinger equations of

UGT and RGT, together with a limited amount of discussion to make them meaningful. (RWR)

APPLICATIONS TO STRONG INTERACTIONS

27254 Topological tunneling and Goldstone gluons. Creutz, M.; Tudron, T.N. (Brookhaven National Laboratory, Upton, New York 11973). *Phys. Rev., D;* **16**: No. 10, 2978-2990(15 Nov 1977).

Canonically quantizing in the temporal gauge $A_0 = 0$, we study the symmetry properties of the gauge theory vacuum under time-independent gauge transformations. A quantum-electrodynamics-like unconfined phase exhibits spontaneously broken symmetry under gauge transformations that do not vanish at spatial infinity. In a confining phase this symmetry should be restored. When in the unconfined phase, assuming it exists, of a theory possessing topologically nontrivial gauge transformations, the physical Hilbert space will admit a discrete symmetry operation related to a tunneling process between discrete classical vacuums. In the confined phase, this symmetry becomes part of a continuous gauge symmetry. We discuss in detail the solvable theories of free photons and the two-dimensional Schwinger model. We also give some nonrigorous arguments that the phase θ associated with the tunneling process may have no physical significance in four-dimensional space-time.

FIELD THEORY

REFER ALSO TO CITATION(S) 27166, 27182, 27212, 27213, 27249, 27422

27255 (SLAC-PUB—1699) **Impact of quantum electrodynamics.** Brodsky, S.J. (Stanford Linear Accelerator Center, Calif. (USA)). Dec 1975. Contract EY-76-S-03-0326. 40p. (CONF-7511141—1). Dep. NTIS, PC A03/MF A01.

From Meson physics facility users group; Los Alamos, NM, USA (10 Nov 1975).

A review is given of recent developments in quantum electrodynamics, particularly those involving tests of muon dynamics as well as quantum electrodynamics tests. A new limit on possible muon composite structure is also given. The impact of quantum electrodynamics and its generalizations, the gauge theories, to other areas of physics, including the weak and strong interactions and the atomic spectrum of new particles. The consequences of scale invariance in hadron, atomic, and nuclear physics are reviewed. 119 references. (JFP)

27256 Instantons and spin forces between massive quarks. Wilczek, F.; Zee, A. (Columbia University, New York, New York 10027). *Phys. Rev. Lett.;* **40**: No. 2, 83-86(9 Jan 1978).

A generalization of Wilson's loop prescription to include spin is proposed. Instantons are shown to generate a spin-spin interaction between quarks. The large splitting between J/psi (3100) and eta/sub c/(2830) may, in fact, be dominated by this mechanism and thus may provide a vivid demonstration of the physical effects of instantons. Heuristic arguments are presented which explain the sign and form of the interaction.

27257 Super-Higgs effect in a new class of scalar models and a model of super QED. Das, A.; Fischler, M.; Rocek, M. (Institute for Theoretical Physics, State University of New York at Stony Brook, Stony Brook, New York 11794). *Phys. Rev., D;* **16**: No. 12, 3427-3436(15 Dec 1977).

We present results on the scalar supermultiplet coupled to supergravity. A locally supersymmetric theory with generalized kinetic and nonderivative interaction terms is found. We discuss a number of examples. Symmetry breakdown and the "super-Higgs" effect are studied, as is a consistent truncation of the SO(4) extended theory. Finally, we find the local extension of supersymmetric massless QED and discuss symmetry breakdown in this system.

27258 Spinning magnets and Jehle's model of the electron. Bartlett, D.F.; Monroy, J.; Reeves, J. (Department of Physics and Astrophysics, University of Colorado, Boulder, Colorado 80309). *Phys. Rev., D;* **16**: No. 12, 3459-3463(15 Dec 1977).

We have improved a classical test of unipolar induction. In this experiment a cylindrical sample of magnetized steel is spun about its axis inside a hollow, insulated steel sphere. According to the moving-line theory of unipolar induction the rotating magnetic field generates an electric field E = (- omega-arrow-right x r) x B in the region exterior to the magnet. This field will have the effect of elevating the potential of the enclosing sphere. We have searched in vain for such an effect and conclude that if the magnetic field lines are moved at all by the rotation of a magnet about its axis they are dragged with a coefficient less than 1.4×10^{-4}. This limit is approximately 100 times more stringent than the 1912 measurement of Kennard. We discuss the application of this work to Jehle's recent model of leptonic charge.

27259 Scalar propagators in a pseudoparticle field. Creamer, D.B. (Department of Physics, University of Washington, Seattle, Washington 98195). *Phys. Rev., D;* **16**: No. 12, 3496-3502(15 Dec 1977).

We derive the propagators for massless scalar particles of isospin 1/2 and 1 in the field of an SU(2) pseudoparticle.

27260 Vacuum structure of the two-dimensional Higgs model. Monsay, E.H.; Tudron, T.N. (Brookhaven National Laboratory, Upton, New York 11973). *Phys. Rev., D;* **16**: No. 12, 3503-3506(15 Dec 1977).

We find that not all of the apparently stable vacuums, parametrized by an angle θ, of the two-dimensional Abelian Higgs model are physically interesting in the presence of quarks. Single and multiple pair production of fractionally charged quarks places limits, determined by the quark charge, on the possible values θ may take.

27261 Gauge-invariant formulation of the self-dual sector. Halpern, M.B. (Department of Physics and Lawrence Berkeley Laboratory, University of California, Berkeley, California 94720). *Phys. Rev., D;* **16**: No. 12, 3515-3519(15 Dec 1977).

The field-strength formulation of non-Abelian gauge theories opens the gate to a description in terms of local gauge-invariant variables. As a first step in this direction, I work out a gauge-invariant formulation of the self-dual sector. A simple extension, using the ideas of Corrigan, Fairlie, and Yates, provides a gauge-invariant characterization of broader regions within the saddle point.

27262 Gauge groups without triangular anomaly. Okubo, S. (Department of Physics and Astronomy, The University of Rochester, Rochester, New York 14627). *Phys. Rev., D;* **16**: No. 12, 3528-3534(15 Dec 1977).

Suppose that G is a simple gauge group governing a unified gauge theory. We shall then prove that the existence or absence of the triangular anomaly is equivalent to the same question for symmetrized third-order Casimir invariants of G. Consequently, we show that the group SU(n) ($n > \text{or} = 3$) is the only simple Lie group with possible triangular anomaly. For this case, the anomaly coefficient has been explicitly computed in terms of the n - 1 parameters specifying irreducible representations of the group SU(n). Various anomaly-free groups have been discussed, and it is argued that the best candidates for anomaly-free simple gauge groups are E_6, SO(4n + 2) ($n > \text{or} = 2$), and the vectorlike SU(n) ($n > \text{or} = 3$) theories.

27263 Constraint on color gauge groups. Okubo, S. (Department of Physics and Astronomy, University of Rochester, Rochester, New York 14627). *Phys. Rev., D;* **16**: No. 12, 3535-3540(15 Dec 1977).

Assuming that the colored gauge group G/sub c/ is not necessarily the SU(3) but an arbitrary simple compace Lie group, we find that cases of G/sub c/ being one of the groups SU(2), SO(4l), SO(2l + 1), Sp(2l), G_2, F_4, E_7, and E_8 will lead to a difficulty with the quark-line rule. Therefore, only the groups SU(n) ($n > \text{or} = 3$), SO(4l + 2) ($l > \text{or} = 1$), and E_6 remain to be possible candidates for G/sub c/. It is argued that the same restriction also applies to any unified simple group G of all strong, weak, and electromagnetic interactions.

27264 Classical solution of the Yang-Mills equations in Minkowski space. Bernreuther, W. (Laboratory for Nuclear Science and Department of Physics, Massachusetts Institute of Technology, Cambridge, Massachusetts 02139). *Phys. Rev., D;* **16**: No. 12, 3609-3611(15 Dec 1977).

A real solution of the Yang-Mills equations in Minkowski space is constructed by means of a conformal transformation.

27265 Comments on a paper by Callan, Coote, and Gross. Hagen, C.R. (Department of Physics and Astronomy, University of Rochester, Rochester, New York 14627). *Phys. Rev., D;* **16**: No. 12, 3612-3614(15 Dec 1977).

A recent work by Callan, Coote, and Gross has attempted to demonstrate quark binding in a two-dimensional gauge theory in light-cone coordinates. Among the assumptions employed in that paper are (a) that there exists a parity operator, (b) that the theory is covariant, (c) that anomalies in the theory present no essential complicatons, and (d) that "singular" cutoffs may be imposed in calculations without regard to considerations of gauge invariance or the equations of motion. Examined within the context of canonical field theory it is argued that none of these conditions is satisfied in the model which they consider.

27266 Zeros of the Fredholm determinant for the external-field problem in Euclidean, massless spin-0 and spin-1/2 electrodynamics. Adler, S.L. (Institute for Advanced Study, Princeton, New Jersey 08540). *Phys. Rev., D;* **16**: No. 10, 2943-2947(15 Nov 1977).

I study the location of zeros, in the plane of complex coupling constant e, of the Fredholm determinant for the external-field problem in Euclidean spin-0 and spin-1/2 electrodynamics. In the massive spin-0 and spin-1/2 cases, a simple argument gives the already

known result that the Fredholm determinant has no zeros for real eA. This result extends to the massless spin-0 case. However, I construct a class of counterexamples which shows that there are zeros for real eA, with A not a pure gauge potential, in massless spin-1/2 electrodynamics. The functional measure of the potentials A obtained from the construction is not determined. The construction is based on the fact that the problem of determining zero eigenvalues in an external field in massless spin-1/2 electrodynamics separates into two uncoupled two-component equations. I discuss possible implications of this result for the study of spinor electrodynamics by nonperturbative path-integral methods.

27267 Yang-Mills theory on the hypertorus. Schechter, B.M. (Center for Theoretical Physics, Laboratory for Nuclear Science and Department of Physics, Massachusetts Institute of Technology, Cambridge, Massachusetts 02139). *Phys. Rev., D;* **16**: No. 10, 3015-3020(15 Nov 1977).

The invariance of pure Yang-Mills theory under the group O(4) x O(2), the maximal compact subgroup of the Minkowski conformal group, is made explicit by projecting the theory onto the surface of a hypertorus. The group O(4) x O(2) has previously arisen as the invariance group of the solution of De Alfaro, Fubini, and Furlan. We find a remarkably simple and elegant expression for this solution on the hypertorus. A new class of solutions is also constructed.

27268 (2 + 1) -dimensional Abelian lattice gauge theory. Baaquie, B.E. (Stanford Linear Accelerator Center, Stanford University, Stanford, California 94305). *Phys. Rev., D;* **16**: No. 10, 3040-3046(15 Nov 1977).

A modified form of the Wilson action is studied for the Abelian field in 2 + 1 dimensions. The system is shown to be identical to the infinite-spin-component generalization of the Ising model. In the weak-coupling limit, the system factorizes into the ordinary Coulomb interaction and a new set of interactions which are a direct reflection of the compactness of the Abelian lattice field. This new interaction is divergent, for d < or = 4, if expanded about the naive vacuum. An exact calculation shows the existence of at least two phases. A mean-field calculation shows the system to be in the same phase for all coupling g^2, except for $g^2 = 0$, where there is a phase transition.

27269 Spectra of fermions in monopole fields: Exactly soluble models. Callias, C.J. (Laboratory for Nuclear Science and Department of Physics, Massachusetts Institute of Technology, Cambridge, Massachusetts 02139). *Phys. Rev., D;* **16**: No. 10, 3068-3077(15 Nov 1977).

We investigate the structure of the energy spectrum of an isospin-1/2 Dirac particle in the field of the SU(2) magnetic monopole of 't Hooft and Polyakov. We show that aside from the zero-energy mode, which is always present, there are at most a finite number of bound states. To clarify the interaction of the fermion with the various components of the monopole field, we consider two different extrapolations of the background field to limiting forms. The corresponding Dirac equations turn out to be exactly soluble. In the first limiting model, only the Higgs field is retained, and the Dirac equation is found to be equivalent to the nonrelativistic Coulomb problem. The second model is just the point monopole, and our problem is equivalent to a doublet of massive Dirac particles interacting with an Abelian magnetic monopole. This classical problem admits a simple treatment in the context of non-Abelian gauge theories; we present its solution in this formulation; we point out the hitherto unnoticed fact that the Hamiltonian is not self-adjoint on the customary domain of nonsingular wave functions and we study its self-adjoint extensions and bound states.

27270 Electric and magnetic dipole moments of the bound system of a Dirac particle and a fixed magnetic monopole. Kazama, Y. (Fermi National Accelerator Laboratory, Batavia, Illinois 60510). *Phys. Rev., D;* **16**: No. 10, 3078-3085(15 Nov 1977).

The electric and the magnetic dipole moments are calculated for the bound states of a charged Dirac particle of spin 1/2 with an extra magnetic moment in the field of a fixed magnetic monopole. Unlike ordinary bound systems with P and/or T invariance, this system, lacking both, is found to possess a nonvanishing electric dipole moment. Its magnitude for the loosely bound states with the lowest possible angular momentum increases exponentially in the principal quantum number n. The magnetic moment of the system is found to be, in general, nonvanishing.

27271 Decay of metastable vacuums in the massive Schwinger model. Pak, N.K. (Department of Physics, B-019, University of California, San Diego, La Jolla, California 92093). *Phys. Rev., D;* **16**: No. 10, 3090-3093(15 Nov 1977).

The unique vacuum of the massive Schwinger model for the $\theta = 0$ sector becomes metastable when $c\theta$ exceeds π. This metastable vacuum decays through barrier penetration. We can get an explicit expression for the decay width, to leading order in h, in the weak-coupling limit.

27272 Path integral formulation of mean-field perturbation theory. Bender, C.M.; Cooper, F.; Guralnik, G.S. (Physics Department, Washington University, St. Louis, Missouri 63130). *Ann. Phys. (N.Y.);* **109**: No. 1, 165-209(Nov 1977).

We develop a convenient functional integration method for performing mean-field approximations in quantum field theories. This method is illustrated by applying it to a self-interacting phi^4 scalar field theory and a J/sup μ//sup Jμ/ four-Fermion field theory. To solve the phi^4 theory we introduce an auxiliary field chi and rewrite the Lagrangian so that the interaction term has the form chi and rewrite the Lagrangian so that the interaction term has the form chiphi^2. The vacuum generating functional is then expressed as a path integral over the fields chi and phi. Since the chi field is introduced to make the action no more than quadratic in phi, we do the phi integral exactly. Then we use Laplace's method to expand the remaining chi integral in an asymptotic series about the mean field chi_0. We show that there is a simple diagrammatic interpretation of this expansion in terms of the mean-field propagator for the elementary field phi and the mean-field bound-state propagator for the composite field chi. The phi and chi propagators appear in these diagrams with the same topological structure that would have been obtained by expanding in the same manner a chiphi^2 field theory in which chi and phi are both elementary fields. We therefore argue that by renormalizing these theories so that the mean-field propagators are equivalent, the two theories are described by the same renormalized Green's functions containing the same three parameters, μ^2, m^2, and g. The quartic theory is completely specified by the renormalized masses μ^2 and m^2 of the chi and phi fields. These two masses determine the couplig constant $g=g(\mu^2,m^2)$. The cubic theory depends on μ^2 and m^2 and a third parameter g_0,$g = g(\mu^2,m^2,g_0)$, where g_0 is the bare coupling constant.

27273 Superunified theories based on the geometry of local (super-) gauge invariance. Mansouri, F. (Stanford Linear Accelerator Center, Stanford University, Stanford, California 94305). *Phys. Rev., D;* **16**: No. 8, 2456-2467(15 Oct 1977).

Based on the geometry of local (super-) gauge invariance, a theoretical framework for constructing superunified theories is given. The main ingredients of this approach are (a) a method of constructing invariants associated with unconstrained gauge theories and (b) the concept of "constrained" geometries for the description of gravity and supergravity as well as the choice of their gauge groups. It is argued that any unified theory must contain gravity, and then, to retain the invariances of pure gravity theory, such a theory must be a superunified one. The formalism is then applied, respectively, to pure gravity, gravity coupled to Yang-Mills fields, simple supergravity, and SO(2) -extended supergravity. Important properties of these theories are discussed in detail.

27274 Field theories in terms of particle-string variables: Spin, internal symmetries, and arbitrary dimension. Halpern, M.B.; Jevicki, A.; Senjanovic, P. (Department of Physics, University of California, Berkeley, California 94720). *Phys. Rev., D;* **16**: No. 8, 2476-2485(15 Oct 1977).

We provide essential tools for a program of rewriting field theories in terms of particle-string variables. The general methods are illustrated in the case of quantum chromodynamics: (1) We find the particle-trajectory representation for the quark Green's functional. (2) Thus, we derive directly correct end-point terms for quarks at the ends of strings. (1) and (2) are for any number of dimensions. (3) In two dimensions, we find a functional bridge from quantum chromodynamics to the Bardeen-Bars-Hanson-Peccei string.

27275 Particle limit of field theory: A new strong-coupling expansion. Halpern, M.B.; Siegel, W. (Department of Physics and Lawrence Berkeley Laboratory, University of California, Berkeley, California 94720). *Phys. Rev., D;* **16**: No. 8, 2486-2499(15 Oct 1977).

We study a new semiclassical expansion of field theory. In this expansion, the natural variables are geometrical (particle coordinates), and the expansion is about solutions to the classical mechanics of such variables. It is a strong-coupling expansion, and it offers considerable hope for bridging the gap between quantum field theories and theories of quantized geometrical objects.

27276 Statistical mechanics of a (1 + 1) -dimensional quantum field theory at finite density and temperature. Thacker, H.B. (Fermi National Accelerator Laboratory, Batavia, Illinois 60510). *Phys. Rev., D;* **16**: No. 8, 2515-2525(15 Oct 1977).

The quantum field theory in one space + one time dimension described by the Lagrangian L = (i/2) phi*partial$_0$phi - (partial$_1$phi*)(partial$_1$phi) - cvertical-barphivertical-bar^4 is studied for systems with finite temperature and particle density. Using momentum-space techniques previously developed, a graphical procedure is obtained for calculating inner products of many-particle scattering state wave functions. The unitarity of the wave operator U (0, -∞) is demonstrated as a pattern of graphical cancellations. An operator formulation of statistical mechanics is derived in which partition functions are given in terms of matrix elements having the form of diagonal (forward) inner products. The importance of noncommuta-

tivity of the forward limit and the $i\epsilon \rightarrow 0$ limit is noted and traced to the presence of forward singular graphs in the inner product. Combining this observation with wave-operator unitarity, we obtain a graphical recipe for calculating N-body partition functions. The thermodynamics first described by Yang and Yang is obtained by summation of the fugacity series for the grand partition function.

27277 U(1) gauge theories, fiber bundles, and stereographic projections in two dimensions. Kiskis, J. (Theoretical Division, Los Alamos Scientific Laboratory, University of California, Los Alamos, New Mexico 87545). *Phys. Rev., D;* **16**: No. 8, 2535-2539(15 Oct 1977).

Some general properties of U(1) gauge fields on R^2 and S^2 are investigated. In the absence of matter fields, configurations which are more general than fiber bundles are allowed on S^2. Fermion fields are not consistent with this more general structure on S^2. Stereographic projections are discussed.

27278 How to compute determinants compactly. Ore, F.R. Jr. (Center for Theoretical Physics, Laboratory for Nuclear Science and Department of Physics, Massachusetts Institute of Technology, Cambridge, Massachusetts 02139). *Phys. Rev., D;* **16**: No. 8, 2577-2580(15 Oct 1977).

The one-loop contribution to the vacuum-to-vacuum amplitude in the presence of a Yang-Mills pseudoparticle is computed in a manifestly O(5) -invariant manner; complete agreement with a previous computation of the same quantity by 't Hooft is proved.

27279 Near-mass-shell infrared behavior of non-Abelian gauge theories and the renormalization group. Poggio, E.C. (Department of Physics, Brandeis University, Waltham, Massachusetts 02154). *Phys. Rev., D;* **16**: No. 8, 2586-2604(15 Oct 1977).

We show the existence of renormalization-group equations that completely determine the infrared structure of near-mass-shell quantum-chromodynamics Green's functions. The formal solutions of these equations are governed completely by the behavior of the long-distance invariant charge g (k^2). In the quark-gluon sector, the existence of these equations depends on choosing the particular near-mass-shell renormalization scheme where gluon and fermion momenta q and p are respectively subtracted at the "equal-rate-on-shell" point $q^2 = -\lambda^2$, γ x p - m = -λ, where m is the physical quark mass. The function that describes the evolution of g (k^2), β/sub IR/ (g (k^2)) = lim/sub k/ k^2(partial/partialk^2) g (k^2), is determined from the infrared structure of the gluon-quark sector alone, and it is shown to equal, explicitly at the one-loop level, β/sub YM/(g (k^2)), the corresponding function of a pure Yang-Mills theory. We have computed explicitly, up to the two-loop level, the near-mass-shell behavior of the color-singlet form factor. Reorganizing all contributions as suggested by our renormalization-group results, we find that, in the Landau gauge, they sum up to the simple form exp[$B_1(p;p';g^2(k^2))$], where $B_1(p;p';g^2(k^2))$ is the one-loop contribution calculated by replacing the bare vertex (-ig/sub lambda)/by the invariant charge [-ig (k)]; where k is the internal soft-gluon momentum. This result is valid to all orders in a near-mass-shell leading-log approximation. The connection of our work with the issue of infrared-driven quark confinement is briefly discussed.

27280 Calculations of the infrared behavior of quantum chromodynamics: The color-singlet quark form factor in the near-mass-shell regime. Poggio, E.C. (Department of Physics, Brandeis University, Waltham, Massachusetts 02154). *Phys. Rev., D;* **16**: No. 8, 2605-2611(15 Oct 1977).

We explicitly calculate at the two-loop approximation the near-mass-shell infrared behavior of the color-singlet quark form factor in quantum chromodynamics (QCD). The sum of all contributions can be reexpressed by the simple form F_1/sup(0) = exp[B_1(g (k);G = - 1)], where B_1(g (k);G = -1) is the one-loop contribution, in the Landau gauge, evaluated by substituting the expansion coupling g/sub lambda/by the infrared invariant charge k^2(partial/partialk^2) g (k^2) = β (g (k^2)); g ($k^2 = \lambda^2$) = g/sub lambda/Various techniques to study the infrared structure of QCD diagrams are outlined.

27281 Gauge fixing and mass renormalization in the lattice gauge theory. Baaquie, B.E. (Stanford Linear Accelerator Center, Stanford University, Stanford, California 94305). *Phys. Rev., D;* **16**: No. 8, 2612-2627(15 Oct 1977).

The lattice gauge theory proposed by Wilson is discussed. Gauge fixing is defined for the lattice theory, and it is shown that gauge fixing is done in this theory solely for calculational purposes. The gauge-fixing method is used to study the mass renormalization of the gauge field quantum. An explicit calculation is done to lowest order which shows that there is no mass renormalization. This same result is proved to all orders in perturbation theory using the Slavnov identity.

27282 Violations of dimensional analysis in renormalized perturbation theory. Ward, B.F.L. (Stanford Linear Accelerator Center, Stanford University, Stanford, California 94305). *Phys. Rev., D;* **16**: No. 8, 2638-2654(15 Oct 1977).

The Green's functions of renormalizable quantum field theory are shown to violate, in general, Euler's theorem on homogeneous functions, that is to say, to violate naive dimensional analysis. The respective violations are established by explicit calculation with Feynman diagrams. These violations, when incorporated into the renormalization group, may provide the basis for an entirely new approach to asymptotic behavior in renormalizable field theory.

27283 Kinetic-energy considerations and the vacuum. Eylon, Y.; Rabinovici, E. (Lawrence Berkeley Laboratory, University of California, Berkeley, California 94720). *Phys. Rev., D;* **16**: No. 8, 2660-2661(15 Oct 1977).

The suppression of infinite kinetic-energy trajectories is related to the topological classification in non-Abelian gauge theories.

27284 Pulsating solitons. Manakov, S.V. (L. D. Landau Institute of Theoretical Physics, USSR Academy of Sciences). *JETP Lett. (USSR) (Engl. Transl.);* **25**: No. 12, 553-556(20 Jun 1977).

Pulsating solutions of the classical equations of neutral scalar fields are constructed. In the nonrelativistic approximation of quantum theory, they correspond to bound states of a large number of bosons. The energy of an N-particle bound state is calculated in the quasiclassical approximation.

27285 Multidimensional method of the inverse scattering problem and duality equations for the Yang-Mills field. Belavin, A.A.; Zakharov, V.E. (L. D. Landau Institute of Theoretical Physics, USSR Academy of Sciences). *JETP Lett. (USSR) (Engl. Transl.);* **25**: No. 12, 567-570(20 Jun 1977).

A general method is proposed for solving nonlinear equations with arbitrary number of variables with the aid of the method of the inverse scattering problem. The method is applicable to nonlinear equations that can be obtained as the conditions for the compatibility of systems of linear equations. By way of application of the method, the most general instanton duality-equation solutions are obtained for Yang-Mills fields.

27286 Rising cross section and the multi-Pomeron bootstrap. Dubovikov, M.S. (Moscow Physico-technical Institute). *Sov. J. Nucl. Phys. (Engl. Transl.);* **25**: No. 4, 461-466(Apr 1977).

Arguments are presented that for a total cross section rising linearly as a function of $\xi = \ln s$ it is possible to make the multi-Pomeron scheme self-consistent if we postulate the existence of several bare Pomerons: poles of first order: and of several singularities (in the ω plane) in the exact Pomeron self-energy part. Consistency of the multi-Pomeron scheme (bootstrap) is achieved if definite relations are satisfied between the coupling constants of the bare Pomerons and the exact self-energy parts.

27287 Conformal-invariant behavior of four-point theories in the ultraviolet limit. Ushveridze, A.G. (Physics Institute of the Academy of Sciences, Georgian SSR). *Sov. J. Nucl. Phys. (Engl. Transl.);* **25**: No. 4, 466-469(Apr 1977).

A method is presented for obtaining scale- and conformal-invariant solutions of four-point field theories in the ultraviolet limit by means of reduction to the three-point problem. To do this a supplementary σ field without a kinetic term is introduced and the Lagrangian is modified accordingly. For the three-point problems the equations in the form of generalized unitarity conditions are then solved.

27288 Collective phenomena and renormalization of nonlinear spinor theories. Eguchi, T. (Univ. of Chicago). pp 13-32 of Quark confinement and field theory. Stump, D.R.; Weingarten, D.H. (eds.). New York; John Wiley and Sons (1977).

From Symposium on quark binding; Rochester, NY, USA (14 Jun 1976).

See CONF-7606132—.

A new approach to collective phenomena and renormalization of nonlinear spinor models is presented. In this approach nonlinear spinor models are converted into equivalent theories involving fermions and collective bosons by a simple rearrangement of perturbation series. For a wide class of nonlinear spinor theories interactions among fermions and collective states are of the renormalizable kind and hence these models themselves turn out to be renormalizable. The equivalence of various four-fermion theories to known renormalizable models is pointed out. The Nambu-Jona-Lasinio model, for instance, is shown to be equivalent to the linear sigma-model. Discussions are given on the origin of dynamical symmetry breakdown in spinor theories.

27289 Fermionic representation of the infrared behavior of pure Yang—Mills fields. Olesen, P. (Univ. of Copenhagen). pp 123-143 of Quark confinement and field theory. Stump, D.R.; Weingarten, D.H. (eds.). New York; John Wiley and Sons (1977).

From Symposium on quark binding; Rochester, NY, USA (14 Jun 1976).

See CONF-7606132—.

Some work is presented on the infrared behavior of the pure Yang—Mills fields obtained during the last year, making certain assumptions valid to any finite order of perturbation theory. The fermionic representation, power behavior of Green functions, and nonanalyticity for possible phase transition are considered. 15 references. (JFP)

27290 Angular momentum in non-Abelian gauge field theories. Huang, K.; Stump, D.R. (Massachusetts Inst. of Tech., Cambridge). pp 203-209 of Quark confinement and field theory. Stump, D.R.; Weingarten, D.H. (eds.). New York; John Wiley and Sons (1977).

From Symposium on quark binding; Rochester, NY, USA (14 Jun 1976).

See CONF-7606132—.

In Yang-Mills theories, there are contributions to the angular momentum due to the longitudinal gauge electric field produced by the sources. In the quantized theory, this can result in states with anomalous angular momentum. An elementary and general discussion of this point is presented.

27291 Demise of light cone field theory. Hagen, C.R. (Univ. of Rochester, NY). pp 221-232 of Quark confinement and field theory. Stump, D.R.; Weingarten, D.H. (eds.). New York; John Wiley and Sons (1977).

From Symposium on quark binding; Rochester, NY, USA (14 Jun 1976).

See CONF-7606132—.

It is shown that the massive spin one-half field is noncovariant in two dimensional light cone coordinates. It is shown that spin one-half is noncovariant in four dimensions as well. It is concluded that since the case of the spin one-half field is an absolute necessity if one is to build a world containing fermions. It seems safe to infer that light cone quantization cannot be useful in the quark binding problem as currently conceived. It is suggested that further work on light cone quantization be focused solely upon the questions of consistency as discussed rather than on applications to model building. 9 references. (JFP)

27292 Weak and electromagnetic interactions at high energies. Part A. Levy, M.; Basdevant, J.L.; Speiser, D.; Gastmans, R. (eds.). New York; Plenum Press (1976). 478p. (CONF-7506176—P1). .

From Proceedings of weak and electromagnetic interactions at high energies; Cargese, France (30 Jun 1975).

Separate abstracts were prepared for the 12 papers presented. (JFP)

27293 Aspects of QED. Lautrup, B. (Univ. of Copenhagen). pp 1-89 of Weak and electromagnetic interactions at high energies. Part A. Levy, M.; Basdevant, J.L.; Speiser, D.; Gastmans, R. (eds.). New York; Plenum Press (1976).

From Proceedings of weak and electromagnetic interactions at high energies; Cargese, France (30 Jun 1975).

See CONF-7506176—P1.

The aspects of quantum electrodynamics considered are simple calculations illustrating fundamental points and a compressed review of the current status and general structural descriptions of quantum electrodynamics. Included are the Casimir effect, conventional quantum electrodynamics, the Born approximation, equivalent photons, Green functions and regularization, renormalization, Callan—Symanzik equation for the photon propagation, the bound-state problem, and some bound-state experiments. 135 references. (JFP)

27294 Status of the analytic calculations of QED sixth order radiative corrections to the electron anomaly. Remiddi, E. (Laboratoire de Physique Theorique, Paris). pp 91-108 of Weak and electromagnetic interactions at high energies. Part A. Levy, M.; Basdevant, J.L.; Speiser, D.; Gastmans, R. (eds.). New York; Plenum Press (1976).

From Proceedings of weak and electromagnetic interactions at high energies; Cargese, France (30 Jun 1975).

See CONF-7506176—P1.

A sketch is given of the method developed in working out the analytic evaluation of some sixth-order contributions to the electron anomaly. The essential features of the method are presented. 28 references. (JFP)

27295 Gauge theories: an introduction. Gastmans, R. (Univ., Louvain, Belgium). pp 109-171 of Weak and electromagnetic interactions at high energies. Part A. Levy, M.; Basdevant, J.L.; Speiser, D.; Gastmans, R. (eds.). New York; Plenum Press (1976).

From Proceedings of weak and electromagnetic interactions at high energies; Cargese, France (30 Jun 1975).

See CONF-7506176—P1.

In these lectures a review is given of problems with V—A theory and the intermediate vector boson model, leading to the study of generalized gauge invariance. Spontaneous symmetry is introduced, and a realistic model is constructed for the leptons. The Weinberg—Salem model is chosen and its main features are presented. The dimensional regularization procedure is studied in order to be able to carry out closed-loop calculations. Applications to ν(anti ν) + e elastic scattering, $e^+e^- \rightarrow \mu^+ + \mu^-$, the self-charge on the neutrino, and the anomalous magnetic moment of the muon. 105 references. (JFP)

27296 Renormalization of gauge fields models. Becchi, C. (Univ., Genoa). pp 173-190 of Weak and electromagnetic interactions at high energies. Part A. Levy, M.; Basdevant, J.L.; Speiser, D.; Gastmans, R. (eds.). New York; Plenum Press (1976).

From Proceedings of weak and electromagnetic interactions at high energies; Cargese, France (30 Jun 1975).

See CONF-7506176—P1.

The purpose of the lectures is to introduce a new regularization independent approach to the renormalization of gauge field models. The analysis is limited to the SU(2) Higgs—Kibble model. Some formal results of Lagrangian field theory are summarized in terms of the Schwinger action principle and their renormalized version is stated. The extension of these results to the full quantum level is discussed. 29 references. (JFP)

27297 Supersymmetry. Zumino, B. (CERN, Geneva). pp 291-303 of Weak and electromagnetic interactions at high energies. Part A. Levy, M.; Basdevant, J.L.; Speiser, D.; Gastmans, R. (eds.). New York; Plenum Press (1976).

From Proceedings of weak and electromagnetic interactions at high energies; Cargese, France (30 Jun 1975).

See CONF-7506176—P1.

Supersymmetry is a symmetry which connects particles of integral spin with particles having half-integral spin, or bosons with fermions. Some examples of supersymmetric field theories are described. Supermultiplets and Lagrangians, gauge invariance and supersymmetry, superspace and superfields are discussed. 28 references. (JFP)

27298 Asymptotic behavior in quantum field theory. Crewther, R.J. (CERN, Geneva). pp 345-457 of Weak and electromagnetic interactions at high energies. Part A. Levy, M.; Basdevant, J.L.; Speiser, D.; Gastmans, R. (eds.). New York; Plenum Press (1976).

From Proceedings of weak and electromagnetic interactions at high energies; Cargese, France (30 Jun 1975).

See CONF-7506176—P1.

The rules for short-distance behavior in field theory and current algebra are explained. Various methods for the renormalization group are reviewed, and applications are restricted to the results of assuming asymptotic freedom or broken scale invariance. Progress is also reported on the properties of operator-product expansions for non-Abelian gauge theories, an awkward technical problem. 266 references. (JFP)

27299 Value and the scope of quantum field theory. Klauder, J.R. (Bell Labs., Murray Hill, NJ). pp 3-13 of Mathematical physics and physical mathematics. Maurin, K.; Raczka, R. (eds.). Boston; D. Reidel Publishing Co. (1976).

From Symposium on mathematical physics and physical mathematics; Warsaw, Poland (25 Mar 1975).

See CONF-740395—.

A personal view of the value and scope of quantum field theory is presented. In this view quantum field theory is the quantum theory of an infinite number of degrees of freedom interacting in essentially any fashion subject only to a few general quantum-mechanical principles. The author suggests that there are models in quantum field theory which cannot be approached in the standard way, and urges their exploration. (RWR)

27300 Cluster expansions and their application to the n-particle structure of weakly coupled quantum field models. Glimm, J. (Institut des Hautes Etudes Scientifiques, Bures-sur-Yvette, France). pp 15-17 of Mathematical physics and physical mathematics. Maurin, K.; Raczka, R. (eds.). Boston; D. Reidel Publishing Co. (1976).

From Symposium on mathematical physics and physical mathematics; Warsaw, Poland (25 Mar 1975).

See CONF-740395—.

In recent years the $p(phi)_2$ model for self-interacting boson quantum fields in two space—time dimensions has been brought to a fairly complete state. Several distinct methods for constructing these field theories exist. The emphasis here is on cluster expansions; this method provides the most detailed structure of the solutions. It is also observed that, by the method of Borel summation, the $(phi)_2{}^4$ model can be constructed from its formal perturbation-series expansion. (RWR)

27301 Euclidean quantum field theory. Guerra, F. (Univ., Salerno, Italy). pp 19-32 of Mathematical physics and physical mathematics. Maurin, K.; Raczka, R. (eds.). Boston; D. Reidel Publishing Co. (1976).

From Symposium on mathematical physics and physical mathematics; Warsaw, Poland (25 Mar 1975).

See CONF-740395—.

Two aspects of Euclidean quantum field theory are considered, one related to the problem of mathematical construction, the other, to physical interpretation. The general structure of Euclidean quantum field theory of boson systems is introduced, and the connection of the Euclidean structure with classical statistical mechanics is exhibited. The lattice approximation strategy, based on the idea that Euclidean field theory can be approximated by a lattice of continuous spins interacting through a nearest-neighbor ferromagnetic coupling, is described. Applications and results, especially in relation to the infinite volume limit and the problem of phase transitions, are given. Finally, a new physical interpretation, according to which the Euclidean field theory can be interpreted as a stochastic field theory in the physical Minkowski space—time, is proposed. 67 references. (RWR)

27302 Bound states, critical points, and recent results in quantum field models. Jaffe, A. (Institut des Hautes Etudes Scientifiques, Bures-sur-Yvette, France). pp 33-38 of Mathematical physics and physical mathematics. Maurin, K.; Raczka, R. (eds.). Boston; D. Reidel Publishing Co. (1976).

From Symposium on mathematical physics and physical mathematics; Warsaw, Poland (25 Mar 1975).

See CONF-740395—.

Constructive quantum field theory provides problems for both physics and mathematics. The mass spectrum for phi_2^4 is considered. References to the classical (Goldstone) picture of symmetry breaking and the situation in three dimensions are made. A number of theorems from other works are collected in this paper, and several conjectures are stated. (RWR)

27303 Charge conservation and gauge invariance. Bialynicki-Birula, I. (Univ., Warsaw). pp 39-51 of Mathematical physics and physical mathematics. Maurin, K.; Raczka, R. (eds.). Boston; D. Reidel Publishing Co. (1976).

From Symposium on mathematical physics and physical mathematics; Warsaw, Poland (25 Mar 1975).

See CONF-740395—.

Direct relation between charge conservation and gauge invariance of quantum electrodynamics is exhibited. If one insists on the charge conservation at all levels of the theoretical description, he is led to consider new types of propagators--charge-conserving propagators. Charge-conserving propagators after renormalization are free of ultraviolet divergencies even in the case of massive neutral vector meson theory without the introduction of indefinite metric. One class of charge-conserving propagators is particularly useful in the description of scattering phenomena because it leads to transition amplitudes which are free of all infrared divergencies.

27304 Conformal invariance of quantum fields in two-dimensional space—time. Kupsch, J.; Ruehl, W.; Yunn, B.C. (Univ., Kaiserslautern, Ger.). pp 53-56 of Mathematical physics and physical mathematics. Maurin, K.; Raczka, R. (eds.). Boston; D. Reidel Publishing Co. (1976).

From Symposium on mathematical physics and physical mathematics; Warsaw, Poland (25 Mar 1975).

See CONF-740395—.

Investigations of conformal invariance are based on the theory of analytic representations of the conformal group and its universal covering group. An infinite set of new operator solutions for the Thirring model with varying spins and dimensions is obtained. This paper is a synopsis of a more detailed work to be published [Ann. Phys. (N. Y.); 89: No. 1, 115-148 (Jan. 1975)]. (RWR)

27305 Conformal expansion for Euclidean Green functions. Todorov, I.T. (Bulgarian Academy of Sciences, Sofia). pp 57-95 of Mathematical physics and physical mathematics. Maurin, K.; Raczka, R. (eds.). Boston; D. Reidel Publishing Co. (1976).

From Symposium on mathematical physics and physical mathematics; Warsaw, Poland (25 Mar 1975).

See CONF-740395—.

Recent work on conformal quantum field theory is reviewed. The discussion is restricted to a model of a self-interacting scalar field in an arbitrary (even) number of space—time dimensions. Euclidean conformal partial wave expansions are used to diagonalize and solve an infinite set of coupled integral equations for connected Green functions without recourse to perturbation theory. The problem of incorporating crossing symmetry of the solution is left open. 1 figure.

27306 Recent developments in nonlinear spinor theories. Duerr, H.P. (Max-Planck-Institut fuer Physik and Astrophysik, Munich). pp 135-161 of Mathematical physics and physical mathematics. Maurin, K.; Raczka, R. (eds.). Boston; D. Reidel Publishing Co. (1976).

From Symposium on mathematical physics and physical mathematics; Warsaw, Poland (25 Mar 1975).

See CONF-740395—.

Nonlinear spinor theories based on spinor fields with anomalous dimension $1/2$ (subcanonical fields) are briefly reviewed. Such theories appear very interesting because they can be scale invariant and, therefore, formally renormalizable, and they do allow the incorporation of local gauge invariance without the addition of independent vector fields. The main part of the lecture is devoted to a discussion of a canonical imbedding of such subcanonical theories. In this extended framework a more conventional approach is again possible and proves highly effective. In particular, the skeleton theory in this framework proves to be conformally invariant under the same condition as required by gauge invariance. The lowest approximation for gauge field-type bound states is nondivergent and automatically yields massless solutions. 32 references.

27307 Constructive approach to nonlinear quantum field theory. Segal, I. (Massachusetts Inst. of Tech., Cambridge). pp 175-184 of Mathematical physics and physical mathematics. Maurin, K.; Raczka, R. (eds.). Boston; D. Reidel Publishing Co. (1976).

From Symposium on mathematical physics and physical mathematics; Warsaw, Poland (25 Mar 1975).

See CONF-740395—.

The general situation today and the developments of recent years are discussed first. New directions of "software" seem to be needed. The proposal is made of going back once again to the canonical quantization formalism and developing it to the maximal level attainable on the basis of advances in the past decade in nonlinear scattering theory and functional integration. The geometry of the solution manifold of a nonlinear wave equation is addressed. (RWR)

27308 Alternative approach to constructive $lambdaPHI_4^4$ quantum field theory. Balaban, T. (Univ., Warsaw); Raczka, R. pp 203-228 of Mathematical physics and physical mathematics. Maurin, K.; Raczka, R. (eds.). Boston; D. Reidel Publishing Co. (1976).

From Symposium on mathematical physics and physical mathematics; Warsaw, Poland (25 Mar 1975).

See CONF-740395—.

This review article considers the explicit construction of interacting quantum scalar fields which satisfy the nonlinear relativistic wave equation in four-dimensional space—time. The canonical quantization of the classical nonlinear relativistic field theory is elaborated. If the initial Cauchy data for the classical field satisfy an appropriate equation, then under the Poisson brackets the interacting field and the asymptotic fields are canonical. The classical evolution operator, the Moeller scattering operators, and the S-operator are thus canonical transformations. It is also shown that, for the class of Cauchy data considered, the generators of the Poincare group are equal to those associated with the free asymptotic fields. This classical field theory with the canonical formulation satisfies locality, relativistic covariance, and asymptotic conditions. An operator quantization must next be obtained; an operator representation of the Heisenberg Lie algebra is constructed, and the quantum S-operator formalism is considered in the present framework. The subject is treated under the following topics: canonical formalism, commutation relations and locality, relativistic covariance, classical scattering operator, construction of local interacting and asymptotic quantum fields, and quantum scattering operator. (RWR)

27309 Unitary unified field theories. Sudarshan, E.C.G. (Univ. of Texas, Austin). pp 441-470 of Mathematical physics and physical mathematics. Maurin, K.; Raczka, R. (eds.). Boston; D. Reidel Publishing Co. (1976).

From Symposium on mathematical physics and physical mathematics; Warsaw, Poland (25 Mar 1975).

See CONF-740395—.

Some recent developments are presented. Attempts to unify electromagnetic and weak interactions are outlined. The theory of unitary, renormalizable, self-coupled vector mesons with dynamical sources is formulated for a general group. With masses introduced as variable parameters, it is shown that the theory so defined is indeed unitary. Diagrammatic rules are developed in terms of a chosen set of fictitious particles. A number of special examples are outlined including a theory with strongly interacting vector and axial-vector mesons and weak vector mesons. Applications to weak interactions of strange particles are briefly outlined.

SCATTERING THEORY

REFER ALSO TO CITATION(S) 27276

27310 New equations for four-body scattering. Karlsson, B.R.; Zeiger, E.M. (Institute of Theoretical Physics, Fack S-402 20 Goeteborg, Sweden). *Phys. Rev., D;* **16**: No. 8, 2553-2562(15 Oct 1977).

We present new equations for four-body scattering, obtained by generalizing our three-body formalism to the four-body case. These equations, although equivalent to those of Faddeev and Yakubovskii, are expressed in terms of singularity-free physical transition amplitudes, and their energy-independent effective potentials require only half-on-shell subsystem transition amplitudes (and bound-state

wave functions) as input. However, due to the detailed index structure of the Faddeev-Yakubovskii formalism, the result of our generalization is considerably more complicated than in the three-body case.

27311 Inverse scattering problem (finite-difference approach). Zakhar'ev, B.N.; Mel'nikov, V.N.; Rudyak, B.V.; Suz'ko, A.A. (Joint Institute for Nuclear Research, Dubna). *Sov. J. Particles Nucl. (Engl. Transl.);* **8**: No. 2, 120-137(Mar 1977).

It is shown that the main logical points of the inverse scattering problem become especially clear in the framework of R-matrix scattering theory in the finite-difference approximation for the Schroedinger equation. Within a unified scheme, different methods are presented for determining the interaction from scattering data in single-channel, many-channel, and many-particle systems, for which exactly solvable finite-dimensional models of the inverse problem are constructed.

PHYSICS RESEARCH (CONT.)

NUCLEAR PHYSICS

27312 (ANL—77-60) **Physics Division annual review, 1 April 1976—31 March 1977.** Garvey, G.T. (Argonne National Lab., Ill. (USA)). 1977. Contract W-31-109-ENG-38. 281p. Dep. NTIS, PC A10/MF A01.

Work of the ANL Physics Division for the year ending in April, 1977, is recounted in brief reports. This work fell into the following areas: the superconducting linac, medium-energy nuclear physics, heavy-ion physics, charged-particle research, accelerator operations, neutron physics, theoretical nuclear physics, and experimental atomic and molecular physics. Thirty pages of publication titles and lists of staff members are also included. (RWR)

27313 (BNL-NCS—50717) **Panel on reference nuclear data and surveys of reference data requirements.** Burrows, T.W.; Pearlstein, S. (eds.). (Brookhaven National Lab., Upton, N.Y. (USA)). Sep 1977. Contract EY-76-C-02-0016. 26p. Dep. NTIS, PC A03/MF A01.

A large number of information centers are engaged in the compilation and evaluation of nuclear data. The U.S. Energy Research and Development Administration (now U.S. DOE) and the National Nuclear Data Center (NNDC) at Brookhaven National Laboratory suggested that the activities of these centers might be served beneficially by the advice of a committee representing the users of nuclear data. On October 19, 1976, an organizational meeting of the Panel on Reference Nuclear Data was held at Brookhaven National Laboratory by the NNDC. Representatives of the various technical societies which encompass the users of nuclear data were invited, along with representatives of the various nuclear data centers, funding agencies, and publishers. Outgrowths of this meeting were a Source List of Nuclear Data Bibliographies, Compilations, and Evaluations and a plan to survey the needs of the scientific community as an aid in the planning of information center activities. Examples of surveys used to poll Technical Society memberships are included in this report, as well as a list of meeting attendees and a summary of minutes of the meeting. (RWR)

EXPERIMENTAL TECHNIQUES

27314 (ORO—4043-37, pp 26-29) **Target cooling (Bates Linac).** Bubb, E.; Altemus, R.; Courtemanche, A.; McCarthy, J. 1977.

In Experiments on the nuclear interactions of pions and electrons. Progress report, December 1, 1976—November 30, 1977.

Since deposited target heat limits accelerator total current, an investigation is made into target cooling, and two cooling systems developed. The design of such a system is diagramed. (JFP)

27315 Hydrogen surface contamination and the storage of ultracold neutrons. Lanford, W.A.; Golub, R. (A. W. Wright Nuclear Structure Laboratory, Yale University, New Haven, Connecticut 06520). *Phys. Rev. Lett.;* **39**: No. 24, 1509-1512(12 Dec 1977).

The results of hydrogen profile measurements on samples prepared by the same methods used for these materials when making ultracold-neutron (UCN) storage bottles show that the surface hydrogen is sufficient to account for the bulk of the anomalous shortening of UCN storage times.

27316 Nuclear physics and investigations with multiply charged ions. Hrynkiewicz, A.; Broda, R.; Wilczynski, J. (Nuclear Physics Institute, Cracow). *Sov. J. Particles Nucl. (Engl. Transl.);* **8**: No. 2, 164-172(Mar 1977).

The review discusses the use of beams of multiply charged ions obtained in accelerators to study nuclear structure, mainly on the basis of studies carried out at the Nuclear Reactions Laboratory of the Joint Institute for Nuclear Research.

NUCLEAR PROPERTIES AND REACTIONS, A=1-5, THEORETICAL

NUCLEAR REACTIONS AND SCATTERING

27317 Coupled channel theory of pion—deuteron reaction applied to threshold scattering. Mizutani, T.; Koltun, D.S. (Department of Physics and Astronomy, University of Rochester, Rochester, New York, 14627, and Swiss Institute for Nuclear Research, CH-5234 Villigen, Switzerland). *Ann. Phys. (N.Y.);* **109**: No. 1, 1-40(Nov 1977).

Scattering and absorption of pions by a nuclear target are treated together in a coupled channel theory. The theory is developed explicitly for the problem of pion scattering and absorption by a deuteron. The equations are presented in terms of the integral equations of three-body scattering theory. The method is then applied in an approximate from to calculate the contribution of pion absorption to the scattering length for pion—deuteron scattering. The sensitivity of the calculated results to the model assumptions and approximations is investigated.

NUCLEAR PROPERTIES AND REACTIONS, A=1-5, EXPERIMENTAL

NUCLEAR REACTIONS AND SCATTERING

27318 (ORO—4043-37, pp 1-5) **Study of ^{3}He(π^-,N)^{2}H and ^{4}He(π^-,N)^{3}H at energies near the (3,3) resonance.** McCarthy, J.; Orphanos, L.; Kaellne, J.; Whitney, R.R. 1977.

In Experiments on the nuclear interactions of pions and electrons. Progress report, December 1, 1976—November 30, 1977.

The differential cross sections of the (π^-, N) reaction was measured for the He isotopes at energies of 50 to 290 MeV. Angular distributions and their implications for various mechanisms are considered at length. 12 references (JFP)

27319 (ORO—4043-37, pp 6) **Angular distribution of the (π^-,π^0) reaction on ^{3}He at 200 to 290 MeV.** McCarthy, J.; Whitney, R.R.; Orphanos, L.; Kaellne, J. 1977.

In Experiments on the nuclear interactions of pions and electrons. Progress report, December 1, 1976—November 30, 1977.

A preliminary analysis is reported for the (π^-, π^0) reaction on ^{3}He. Differential cross sections were so far obtained at the backward angles for incident pion energies of 200 to 290 MeV. A relatively structureless angular distribution with an order of magnitude near 10 μb/sr is observed. Charge symmetry and noncoherent processes can be studied from these results. 3 references. (JFP)

27320 (ORO—4043-37, pp 8-11) **Elastic scattering of π^{+-} on ^{3}He and ^{3}He.** McCarthy, J.; Minehart, R.C.; Roeder, D.L.; Wadlinger, E.A. 1977.

In Experiments on the nuclear interactions of pions and electrons. Progress report, December 1, 1976—November 30, 1977.

The elastic differential cross section for π/sup +-/ reactions with ^{3}H and ^{3}He at 233 to 300 MeV/c was measured. This analysis is as yet incomplete. The primary objective was to measure the cross section for the reaction $\pi^+ + {}^3\mathrm{H} \rightarrow \gamma + {}^3\mathrm{He}$, which when compared with an existing measurement of the inverse process provides a test of the principle of detailed balance. (JFP)

27321 (ORO—4043-37, pp 30-32) **Threshold effects in the electrodisintegration of ^{3}He (Stanford Linac).** McCarthy, J.S.; Miller, R.R.; Whitney, R.R. 1977.

In Experiments on the nuclear interactions of pions and electrons. Progress report, December 1, 1976—November 30, 1977.

Data on ^{3}He(e,e') were obtained at beam energies of 170 to 300 MeV. The studied threshold behavior is the rapid rise of the cross section just after the p + d threshold. A monopole excitation is identified. 3 references. (JFP)

27322 (ORO—4043-37, pp 46-48) **Threshold electrodisintegration and quasi-free scattering from ^{3}He.** Day, D.; McCarthy, J.; Sick, I. 1977.

In Experiments on the nuclear interactions of pions and electrons. Progress report, December 1, 1976—November 30, 1977.

Counts per bin are given as preliminary results of an experiment measuring elastic electron reactions with helium-3 and -4. Analysis of the high resolution data taken in the threshold and quasielastic regions is still in progress. 2 references. (JFP)

27323 Study of pion-absorption mechanisms in ^{4}He and other nuclei. Jackson, H.E.; Tabor, S.L.; Rehm, K.E.; Schiffer, J.P.; Segel, R.E.; Rutledge, L.L. Jr.; Yates, M.A. (Argonne National Labora-

tory, Argonne, Illinois 60439). *Phys. Rev. Lett.;* **39**: No. 25, 1601-1604(19 Dec 1977).

The spectrum and yield of protons produced by 60-, 100-, and 200-MeV π^+ and π^- beams on targets of ^{4}He, ^{12}C, ^{62}Ni, and ^{181}Ta have been measured at 45° and 90°. A distinct high-energy component is seen in the protons from ^{4}He, which is consistent with a two-body absorption mechanism. Its cross section at 220 MeV is somewhat larger than calculated from the π^+ + D process. Possible evidence is also seen for multinucleon absorption modes. The data on heavier nuclei are consistent with earlier experiments.

27324 Analyzing-power measurements for the ^{3}He(t,d)^{4}He reaction. Haglund, R.F. Jr.; Ohlsen, G.G.; Hardekopf, R.A.; Jarmie, N.; Brown, R.E. (Los Alamos Scientific Laboratory, Los Alamos, New Mexico 87545). *Phys. Rev., C;* **16**: No. 6, 2151-2158(Dec 1977).

We report analyzing-power angular distributions for the ^{3}He(t,d)^{4}He reaction at bombarding energies of 9.02, 12.86, and 17.02 MeV, and an excitation function at 90° c.m. from 9.02 to 17.27 MeV. The angular distributions show marked deviations from the antisymmetric shape predicted by a simple particle-transfer model incorporating charge symmetry. Reaction mechanisms and violations of charge symmetry which might account for the data are discussed.

27325 Statistical analysis of ^{4}He(p,p)^{4}He data. Jarmie, N. (Los Alamos Scientific Laboratory, University of California, Los Alamos, New Mexico 87545). *Phys. Rev., C;* **16**: No. 5, 2090-2091(Nov 1977).

A statistical study is made of 1131 ^{4}He(p,p)^{4}He scattering data from 91 experiments in the range 0 to 18 MeV. A goodness-of-fit test is made comparing the 91 data subsets to the R-matrix predictions of Dodder et al., who use these data. The result is generally satisfactory indicating a proper random fluctuation of the experimental data sets; however, there is some evidence of an overestimation of errors in several experiments.

NUCLEAR PROPERTIES AND REACTIONS, A=6-19 THEORETICAL

RADIOACTIVE DECAY

27326 Beta decays and related processes in the A = 14 nuclei. Goulard, B.; Lorazo, B.; Primakoff, H.; Vergados, J.D. (Laboratoire de Physique Nucleaire, Universite de Montreal, C.P. 6128, Montreal, Quebec, Canada). *Phys. Rev., C;* **16**: No. 5, 1999-2009(Nov 1977).

We present an analysis of the processes $^{14}C(^{14}O) \rightarrow {}^{14}N + e^-$ (e^+) + nu-bar/sub e/ (ν/sub e/) and μ^- + ^{14}N → ν/sub μ/14C (ground state) on the basis of an "elementary particle" treatment and of a "microscopic" treatment including the nucleons-only impulse approximation and the meson exchange. The elementary particle treatment in conjunction with data on e^- + ^{14}N → e^- + ^{14}N* (2.31 MeV), conserved vector current, partially conserved axial-vector current, and a possible second-class axial current, yields 50 sec^{-1} < [Γ (μ^- + ^{14}N → ν/sub μ/14C (ground state))]/sub stat.av./ < 70 sec^{-1} and 95 sec^{-1} < [Γ (μ^- + ^{14}N → ν/sub μ/14C (ground state))]/sub F/ < 210 sec^{-1}. The microscopic treatment leads to the conclusion that the nucleons-only-impulse-approximation and meson-exchange contributions to the $^{14}C(^{14}O) \rightarrow {}^{14}N + e^-$ (e^+) + nu-bar/sub e/ (ν/sub e/) amplitude may well be opposite in sign and comparable in magnitude so that the destructive interference between them contributes significantly to the anomalously small values of Γ ($^{14}C(^{14}O) \rightarrow {}^{14}N + e^-$ (e^+) + nu-bar/sub e/ (ν/sub e/)) and [Γ (μ^- + ^{14}N → ν/sub μ/14C (ground state))]/sub stat.av.,f/.

NUCLEAR REACTIONS AND SCATTERING

27327 Pre-equilibrium particle decay in the photonuclear reactions. Wu, J.R.; Chang, C.C. (Department of Physics and Astronomy, University of Maryland, College Park, Maryland 20742). *Phys. Rev., C;* **16**: No. 5, 1812-1824(Nov 1977).

Calculations of particle energy spectra resulting from the photonuclear reactions at energies below the meson production threshold have been carried out in the framework of combining the pre-equilibrium exciton model and the quasideuteron model. A 2p-2h initial state in the exciton model is assumed because the quasideuteron absorption is the dominant process in the energy region above giant resonance. With this combined model the subsequent secondary interactions of the emerging particle with the rest of the nucleus following the initial photon-nucleus interaction are appropriately taken into account. The experimental difference energy spectra of fast photoneutrons from several elements (Al, Cu, In, Sn, Ta, Pb, Bi, and U) at bremsstrahlung energies of 55 and 85 MeV were compared with the theoretical predictions. General agreements in both spectral shapes and cross sections are obtained. The relative yields of the reactions (γ,xn) resulting from monoenergetic photons on ^{127}I at 50, 100, and 150 MeV are also predicted reasonably well by the combined model together with the conventional evaporation theory.

27328 Folding model description of heavy ion inelastic scattering. Moffa, P.J.; Dover, C.B.; Vary, J.P. (Physics Department, University of Maryland, College Park, Maryland 20742). *Phys. Rev., C;* **16**: No. 5, 1857-1864(Nov 1977).

We develop a macroscopic description of heavy ion inelastic scattering in the context of a folding model. Form factors for the single nuclear excitation of either the projectile or target are derived, as well as the mutual excitation form factor. The formalism is applied to several typical examples.

27329 Neutron and proton knockout from ^{19}F and ^{27}Al by negative pions. Sternheim, M.M.; Silbar, R.R. (Department of Physics and Astronomy, University of Massachusetts, Amherst, Massachusetts 01003). *Phys. Rev., C;* **16**: No. 5, 2059-2061(Nov 1977).

Upper limits on the ratio of neutron to proton knockout to the (2^+,T = 1) analog levels in ^{19}F and ^{27}Al by π^- at 200 MeV are consistent with the nucleon charge exchange model, as modified by nuclear structure considerations. In contrast, the impulse approximation and a semiclassical nucleon charge exchange model give ratios which are larger than the upper bounds. In comparing cross sections involving different final residual nuclei, it is important to consider the relative fragility of the daughter nuclei.

NUCLEAR PROPERTIES AND REACTIONS, A=6-19, EXPERIMENTAL

ENERGY LEVELS AND TRANSITIONS

27330 Pair decay of the 7.65-MeV level of ^{12}C. Alburger, D.E. (Brookhaven National Laboratory, Upton, New York 11973). *Phys. Rev., C;* **16**: No. 6, 2394-2400(Dec 1977).

The ground-state nuclear pair decay branch from the 7.65-MeV 0^+ level in ^{12}C has been measured using the reaction $^{12}C(p,p')^{12}C$ on a 3.5-mg/cm^2 thick carbon target at E/sub p/ = 10.5 MeV together with a magnetic pair spectrometer. For normalization the internal pair line due to the 4.44-MeV E2 transition from the first-excited state of ^{12}C was used. In separate measurements the corresponding relative populations of the 7.65- and 4.44-MeV states were determined. The angular distribution of the 4.44-MeV γ rays was also measured in order to obtain the correction to the spectrometer efficiency due to nuclear alignment. A pair decay branch of (7.1 +- 0.8) x 10^{-6} was obtained for the 7.65-MeV level in agreement with, but somewhat more accurate than previous measurements.

NUCLEAR REACTIONS AND SCATTERING

REFER ALSO TO CITATION(S) 27323

27331 (ANL—77-60, pp 108-109) **Direct and resonance photoneutron reactions of ^{17}O.** Laszewski, R.M.; Holt, R.J.; Jackson, H.E. 1977.

In Physics Division annual review, 1 April 1976—31 March 1977.

The differential cross section for the $^{17}O(\gamma,r_0)^{16}O$ reaction was measured at high resolution from 4.5 to 7.1 MeV. A preliminary R-matrix analysis indicated that the background cross section is predominately p/sub 3/2/ in character. The reduced transition probability for the 5.08-MeV resonance was 1.4 μ_0^2. 1 figure. (RWR)

27332 (LBL—670) **Proton and pion spectra at large angles in relativistic heavy-ion collisions.** Nagamiya, S.; Tanihata, I.; Schnetzer, S.; Anderson, L.; Brueckner, W.; Chamberlain, O.; Shapiro, G.; Steiner, H. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Aug 1977. Contract W-7405-ENG-48. 28p. (CONF-770873—3; CONF-770968—11). Dep. NTIS, PC A03/MF A01.

From 7. international conference on high energy physics and nuclear structure; Zurich, Switzerland (30 Aug 1977).

In collisions of 800 MeV/N C on C and Pb, and of 800 MeV/N Ne on NaF, Cu, and Pb, energy and angular distributions of light charged fragments were measured at angles from 15 to 145° by a magnetic spectrometer for fragment energies up to a few GeV. The inclusive spectra are presented as well as some results and discussion of future possibilities for two or more particle coincidence experiments.

27333 (ORO—4043-37, pp 23-24) **Measurement of the $^{12}C(\pi^+, \pi^+ + p)^{11}B$ reaction cross section.** Comiso, J.C.; Boswell, J.; Minehart, R.C.; Wadlinger, E.A.; Ziock, H.J.; Ziock, K.O.H.; Ziock, K.P. 1977.

In Experiments on the nuclear interactions of pions and electrons. Progress report, December 1, 1976—November 30, 1977.

The cross section structure and its implications are discussed for a detailed study of $^{12}C(\pi^+, \pi^+ + p)^{11}B$ coincident events at 100 and 130 MeV in an experiment now underway. (JFP)

27334 Properties of inclusive (π^+,π^0) reactions in nuclei. Bowles, T.; Geesaman, D.F.; Holt, R.J.; Jackson, H.E.; Laszewski,

R.M.; Specht, J.R.; Rutledge, L.L. Jr.; Segel, R.E.; Redwine, R.P.; Yates-Williams, M.A. (Argonne National Laboratory, Argonne, Illinois 60439). *Phys. Rev. Lett.;* **40**: No. 2, 97-99(9 Jan 1978).

Nuclear pion single charge exchange has been studied using a method of π^0 detection based on the spectroscopy of the band-angle decay γ ray. For incident 100-MeV positive pions, charge-exchange scattering from nuclei ranging from Be to Pb was studied. For all targets the π^0 spectra were broad, extending over the entire range 0—100 MeV. Data were taken at 40° and 120° and in all cases the data show a backward peaking. The yields vary about as A/sup 2/3/ .

27335 Neutron deformation parameter from comparative study of π^+ and π^- inelastic scattering. Iversen, S.; Obst, A.; Seth, K.K.; Thiessen, H.A.; Morris, C.L.; Tanaka, N.; Smith, E.; Amann, J.F.; Boudrie, R.; Burleson, G.; Devereux, M.; Swenson, L.W.; Varghese, P.; Boyer, K.; Braithwaite, W.J.; Cottingame, W.; Moore, C.F. (Northwestern University, Evanston, Illinois 60201). *Phys. Rev. Lett.;* **40**: No. 1, 17-20(2 Jan 1978).

Differential cross sections for the excitation of the 2^+ state in ^{18}O by 230-MeV pions are found to be about 70% larger for π^- than for π^+. Since the π-nucleon interaction at this energy is dominated by the (3,3)resonance, it is concluded that the results imply that $<\beta R>$/sub n/ $\simeq 1.3<\beta R>$/sub p/, or alternatively, that (βR)/sub n/(valence neutrons) $\simeq 3(\beta R)$/sub c/(core), where β is the deformation parameter and R the equilibrium radius of the deformed potential. We believe that these results constitute the first example of measurement of the neutron deformation parameter.

27336 Mechanisms for Li and Be production in the $^{14}N + ^{12}C$ reaction. Stokstad, R.G.; Namboodiri, M.N.; Chulick, E.T.; Natowitz, J.B.; Hanson, D.L. (Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830). *Phys. Rev., C;* **16**: No. 6, 2249-2258(Dec 1977).

Measurements of the yields of /sup 6,7/Li and /sup 7,9/Be have been made for the $^{14}N + ^{12}C$ reaction at E/sub 14N/ = 86.9 and 157.0 MeV. Statistical model calculations are compared with the data in order to determine the reaction mechanism. It is concluded that more than half of the total Li and Be yield at these bombarding energies arises from processes other than compound nucleus formation and the subsequent evaporation of a /sup 6,7/Li or /sup 7,9/Be nucleus. The most likely production mechanism at high bombarding energies appears to be the decay of a projectile-like fragment excited in a peripheral collision.

27337 Absolute cross sections for deuteron-induced reactions on ^{6}Li at energies below 1 MeV. Elwyn, A.J.; Holland, R.E.; Davids, C.N.; Meyer-Schutzmeister, L.; Monahan, J.E.; Mooring, F.P.; Ray, W. Jr. (Argonne National Laboratory, Argonne, Illinois 60439). *Phys. Rev., C;* **16**: No. 5, 1744-1756(Nov 1977).

Absolute cross sections for (d,n), (d,p), and (d,α) reactions initiated by ~0.1 to ~1.0 MeV deuterons on ^{6}Li have been obtained. Total reaction cross sections, with absolute accuracies of 8—13 %, as well as measured differential cross sections are presented. The experimental procedures are discussed and a comparison with previous results is given.

NUCLEAR PROPERTIES AND REACTIONS, A=20-38, THEORETICAL

NUCLEAR REACTIONS AND SCATTERING

REFER ALSO TO CITATION(S) 27327

27338 (BNL—23461) **Surface transparent potentials: forward angle transfer and backward angle elastic scattering in heavy-ion collisions.** Auerbach, E.H.; Baltz, A.J.; Golin, M. Kahana, S.H. (Brookhaven National Lab., Upton, N.Y. (USA)). 1977. Contract EY-76-C-02-0016. 34p. (CONF-771059—7). Dep. NTIS, PC A03/MF A01.

From Symposium on heavy-ion elastic scattering; Rochester, NY, USA (25 Oct 1977).

Two recent works are described which have in common the use of so-called surface transparent optical potentials. The optical potentials are classified in a simple-minded fashion according to the nature of their absorptive parts. The specific reactions considered are: (^{16}O,^{18}O) reactions to the ground and 2_1^+ excited states of ^{18}O near 65 MeV on several Ni isotopes and backward angle elastic and inelastic scattering in the $^{16}O + ^{28}Si$ system near 35 MeV in the center of mass ($E(0_{16}) = 55$ MeV, $E(^{28}Si) = 96.25$ MeV). Various cross sections are plotted. 26 references. (JFP)

NUCLEAR PROPERTIES AND REACTIONS, A=20-38, EXPERIMENTAL

ENERGY LEVELS AND TRANSITIONS

27339 Reappraisal of the ^{24}Mg(^{3}He,t)^{24}Al data to low-lying 1^+ states. Peterson, R.J. (Nuclear Physics Laboratory, Department of Physics and Astrophysics, University of Colorado, Boulder, Colorado 80309). *Phys. Rev., C;* **16**: No. 6, 2424-2425(Dec 1977).

A recent high resolution study of ^{24}Mg(^{3}He,t) found that the cross section to a presumed single 1^+ state of ^{24}Al at 1.12 MeV is in fact a doublet. This peak in the spectra was successfully separated into two peaks in a reanalysis of our previous data, and the new results were compared with the earlier discussion of the reaction mechanism. It is found that a new state of spin $(1,2,3)^+$ exists near 1.12 MeV in ^{24}Al.

NUCLEAR REACTIONS AND SCATTERING

REFER ALSO TO CITATION(S) 27332, 27360

27340 (ANL—77-60, pp 40-41) **Systematics of O + Mg fusion.** Tabor, S.L.; Geesaman, D.F.; Henning, W.; Kovar, D.G.; Rehm, K.E.; Prosser, F.W. Jr. 1977.

In Physics Division annual review, 1 April 1976—31 March 1977.

The cross section of complete fusion of $^{16}O + ^{24}Mg$ is shown from 0.02 to 0.056 E/sub c.m./$^{-1}$. It increases smoothly with energy, then saturates at about 1100 mb. The results indicate that the large deformation and collectivity of the target have no large effect on the fusion cross section. 1 figure. (RWR)

27341 (ANL—77-60, pp 41-43) **Energy dependence of $^{32}S + ^{24}Mg$ fusion cross sections.** Kovar, D.G. (Brookhaven National Lab., Upton, NY); Bond, P.D.; Flaum, C.; LeVine, M.J.; Thorn, C.E. 1977.

In Physics Division annual review, 1 April 1976—31 March 1977.

The energy dependence of the fusion and total reaction cross sections are exhibited for the $^{32}S + ^{24}Mg$ system at laboratory bombarding energies from 100 to 200 MeV. Fusion cross sections saturate at approximately 1100 mb near 53 MeV (c.m.). 1 figure. (RWR)

27342 Coincidence measurements of quasielastic pion scattering by ^{27}Al and ^{208}Pb. Swenson, L.W.; Sharma, T.; Krane, K.; Varghese, P.; McDaniels, D.K.; Thiessen, H.A.; Tanaka, N.; Greenfield, M.; Moore, C.F. (Oregon State University, Corvallis, Oregon 97330). *Phys. Rev. Lett.;* **40**: No. 1, 10-13(2 Jan 1978).

A coincidence measurement of the quasifree scattering of 255-MeV pions by ^{27}Al and ^{208}Pb targets has been made. The measured results for the ratio of π^+ to π^- cross sections of 7.0 +- 0.7 for ^{27}Al and 4.5 +- 0.5 for ^{208}Pb are substantially below the classical impulse-approximation value of 9, showing the influence of charge exchange by the outgoing nucleons. The observed A dependence of this cross-section ratio is in agreement with the predictions of a simplified calculation based on the semiclassical charge-exchange theory for the knockout process.

27343 Elastic electron scattering from the multipole moment distributions of ^{25}Mg. Euteneuer, H.; Rothhaas, H.; Schwentker, O.; Moreira, J.R.; de Jager, C.W.; Lapikas, L.; de Vries, H.; Flanz, J.; Itoh, K.; Peterson, G.A.; Webb, D.V.; Barber, W.C.; Kowalski, S. (Institut fuer Kernphysik, Universitaet Mainz, 65 Mainz, West Germany). *Phys. Rev., C;* **16**: No. 5, 1703-1711(Nov 1977).

Elastic electron scattering cross sections of ^{25}Mg were measured over a momentum transfer range from 0.19 to 2.56 fm^{-1} at both forward and backward angles. Information on all of the ground state multipole moments of both Coulomb and magnetic character has been obtained.

27344 Low energy elastic scattering from ^{28}Si targets using projectiles with 9 < or = A < or = 18. Eck, J.S.; Gray, T.J.; Gardner, R.K. (Department of Physics, Kansas State University, Manhattan, Kansas 66506). *Phys. Rev., C;* **16**: No. 5, 1873-1877(Nov 1977).

A survey of elastic scattering angular distributions from ^{28}Si using beams of ^{9}Be, ^{12}C, ^{14}N, ^{16}O, and ^{18}O has been carried out for energies near the Coulomb barrier. The projectile bombarding energies used were ^{9}Be(14,17 MeV); ^{12}C(24,27,30 MeV); ^{14}N(27,30,33 MeV); ^{16}O(33,36,38 MeV) and ^{18}O(36 MeV). Optical model analyses using a previously proposed parameter set have been carried out in order to fit the data in a global manner. Although low energy data cannot completely define the optical model potential, it is interesting that the potential of Cramer et al., which they used to describe $^{16}O + ^{28}Si$ scattering in the energy range from 33—215 MeV, yields a reasonable description of all the angular distributions for all projectiles and energies presented here.

27345 **Low-lying states in ^{39}Ar from the ^{37}Cl(α,d)^{39}Ar reaction.** Tonn, J.F.; Segel, R.E.; Corwin, W.C.; Rutledge, L.R. Jr. (Argonne National Laboratory, Argonne, Illinois 60439). *Phys. Rev., C;* **16**: No. 5, 2065-2069(Nov 1977).

The ^{37}Cl(α,d)^{39}Ar reaction has been studied at a bombarding energy of 27 MeV. Peaks corresponding to at least 25 states in ^{39}Ar were identified. The strongest-fed states were those at 5.26 and 5.54 MeV, while the 3.38 MeV state was very weak. Angular distributions were measured for several of the stronger states and the data compared to distorted-wave Born approximation calculations.

27346 **High-spin states in A ≅ 40 nuclei: Data for ^{38}Ar and ^{39}K.** Warburton, E.K.; Kolata, J.J.; Olness, J.W. (Brookhaven National Laboratory, Upton, New York 11973). *Phys. Rev., C;* **16**: No. 5, 2075-2077(Nov 1977).

Previous results for high-spin decay schemes in ^{38}Ar and ^{39}K obtained by the Brookhaven group from heavy-ion fusion-evaporation γ-ray spectroscopy are revised and some new results are given. In particular, guided by recently published particle-γ coincidence measurements, we find that in both nuclei the time sequences of two γ transitions in cascade were wrongly ordered. Thus, in ^{38}Ar a 7609-keV level is replaced by a J/sup π/(7$^-$) 8972-keV level, while in ^{39}K a 4831-keV level is replaced by a 7142-keV level. In addition, new mean lives of 17 +- 3 and 20 +- 1.5 ps were extracted for the ^{39}K 6476- and 8029-keV levels, respectively.

NUCLEAR PROPERTIES AND REACTIONS, A=39-58, EXPERIMENTAL

REFER ALSO TO CITATION(S) 27338

RADIOACTIVE DECAY

REFER ALSO TO CITATION(S) 27355

ENERGY LEVELS AND TRANSITIONS

REFER ALSO TO CITATION(S) 27355

27347 (ANL—77-60, pp 80-82) **Gamma decay and lifetime measurements of the isomeric 19-/2 state in ^{43}Ti.** Meyer-Schuetzmeister, L. (Western Michigan Univ., Kalamazoo); Hardie, G.; Elwyn, A.J.; Rehm, K.E. 1977.

In Physics Division annual review, 1 April 1976—31 March 1977.

Gamma radiation from the ^{40}Ca(α,n)^{43}Ti reaction was measured. An isomeric $^{19}/_{2}^{-}$ state at 3066.4 keV had a lifetime of 850 +- 50 ns. Levels in ^{43}Ti and B(E2) values are shown. 1 figure, 1 table. (RWR)

27348 **Test of time reversal invariance in ^{57}Fe.** Cheung, N.K.; Henrikson, H.E.; Boehm, F. (California Institute of Technology, Pasadena, California 91125). *Phys. Rev., C;* **16**: No. 6, 2381-2393(Dec 1977).

An experiment has been performed to test time reversal invariance by observing the angular distribution of the linear polarization of the mixed E2 and M1 122 keV γ rays in ^{57}Fe emitted from oriented ^{57}Co nuclei. Nuclear orientation was achieved with a high magnetic field (the 288 kG hyperfine field of ^{57}Co in an iron lattice) and a low temperature (16.5 to 18 mK obtained with a ^{3}He-^{4}He dilution refrigerator). If time reversal invariance is violated, a term in the angular distribution of the form (J x k x E) (J x k) (J x E)sineta would be present, where the vectors k and E describe the propagation and linear polarization of the γ ray, respectively, and J is the nuclear orientation vector. The quantity eta is the phase angle between the E2 and M1 matrix elements of the γ transition. In our experiment the linear polarization was measured with a Compton polarimeter using an aluminum scatterer and NaI(Tl) detectors. From the observed asymmetry of A = (-0.35 +- 0.78) x 10^{-5}, a value of sineta = (-3.1 +- 6.5) x 10^{-4} was obtained. This result is consistent with time reversal invariance. Possible small contributions to the phase angle from atomic and nuclear final state effects are discussed.

27349 **^{56}Fe(^{3}He,t)^{56}Co reaction.** Zimmerman, W.R.; Kraushaar, J.J.; Schneider, M.J.; Rudolph, H. (Nuclear Physics Laboratory, Department of Physics and Astrophysics, University of Colorado, Boulder, Colorado 80309). *Phys. Rev., C;* **16**: No. 6, 2432-2436(Dec 1977).

The ^{56}Fe(^{3}He,t)^{56}Co reaction has been studied at 38.2 MeV incident beam energy. Angular distributions have been obtained for 20 levels ranging in energy up to the isobaric analog states at 3511 and 3577 keV. Spins and parities have been assigned for most of the levels based on a comparison with distorted-wave Born approximation calculations.

NUCLEAR REACTIONS AND SCATTERING

REFER ALSO TO CITATION(S) 27334, 27357

27350 (ANL—77-60, pp 39-40) **Fusion of ^{16}O + ^{40}Ca.** Geesaman, D.F.; Daneshvar, K.; Davids, C.N.; Henning, W.; Kovar, D.G.; Prosser, F.W. Jr.; Rehm, K.E.; Schiffer, J.P.; Tabor, S.L.; Zeidman, B. 1977.

In Physics Division annual review, 1 April 1976—31 March 1977.

The dependence of the fusion cross section of ^{16}O + ^{40}Ca on c.m. energy from 32 to 45 MeV is shown. No evidence was observed for any oscillatory structure greater than 10 percent in amplitude. 1 figure. (RWR)

27351 (ANL—77-60, pp 45-48) **Energy dependence of the distribution of reaction strength in the ^{16}O + ^{40}Ca collisions.** Kovar, D.G. (Univ. of California, Berkeley); Daneshvar, K.; Vigdor, S.E.; Sperr, P.; Mahoney, J.; Menchaca-Rocha, A.; Olmer, C.; Zisman, M. 1977.

In Physics Division annual review, 1 April 1976—31 March 1977.

To investigate in detail how direct channels are affected by the onset of damping processes, measurements were made at 75 MeV. Comparison of these measurements with others at 56 MeV shows that, despite an increase of about a factor of 3 in the direct reaction strength, the distribution of strength among the outgoing channels is similar. DWBA calculations for single-nucleon transfer predict the large increases in cross sections rather well; however, the shapes of the angular distributions are still not well reproduced. 3 figures. (RWR)

27352 (ANL—77-60, pp 50-52) **Inelastic scattering of ^{16}O on even-Ca isotopes.** Rehm, K.E.; Erskine, J.R.; Henning, W.; Kovar, D.G.; Macfarlane, M.H.; Pieper, S.C. 1977.

In Physics Division annual review, 1 April 1976—31 March 1977.

Angular distributions are presented for the inelastic scattering of ^{16}O from even Ca isotopes to the lowest 2$^+$ and 5$^-$ states. DWBA calculations are also shown. 2 figures. (RWR)

27353 **Cross sections for (n,2n) and (n,3n) reactions above 14 MeV.** Veeser, L.R.; Arthur, E.D.; Young, P.G. (Los Alamos Scientific Laboratory, University of California, Los Alamos, New Mexico 87545). *Phys. Rev., C;* **16**: No. 5, 1792-1802(Nov 1977).

Cross sections for (n,2n) and (n,3n) reactions have been measured between 14.7 and 24.0 MeV using a large liquid scintillator to detect neutrons. Measurements were made for ^{45}Sc, ^{59}Co, ^{89}Y, ^{93}Nb, ^{103}Rh, ^{169}Tm, ^{175}Lu, ^{181}Ta, ^{197}Au, and ^{209}Bi samples. The excitation functions are compared with calculations based on a statistical, preequilibrium model using global sets of optical model and level density parameters.

NUCLEAR PROPERTIES AND REACTIONS, A=59-89, THEORETICAL

NUCLEAR REACTIONS AND SCATTERING

REFER ALSO TO CITATION(S) 27327, 27338

27354 **Equilibrium, pre-equilibrium, and direct processes in the (n,n') reaction.** Biryukov, N.S.; Zhuravlev, B.V.; Sal'nikov, O.A.; Trykova, V.I. (Physics and Power Engineering Institute). *Sov. J. Nucl. Phys. (Engl. Transl.);* **25**: No. 4, 408-410(Apr 1977).

Spectra and angular distributions of neutrons inelastically scattered by Co, Y, and Nb nuclei at an initial energy 9.1 +- 0.2 MeV are analyzed with a view to determining the mechanism of the reaction. The contribution of equilibrium, pre-equilibrium, and direct processes to the neutron inelastic scattering cross section has been determined. It is shown that the neutron energy spectra can be described in terms of the mechanism of equilibrium decay of the nucleus and direct reactions without taking into account pre-equilibrium emission.

NUCLEAR PROPERTIES AND REACTIONS, A=59-89, EXPERIMENTAL

RADIOACTIVE DECAY

27355 (ANL—77-60, pp 58-61) **New isotopes of interest to explosive nucleosynthesis.** Davids, C.N.; Geesaman, D.F.; Murphy, M.J.; Norman, E.B.; Pardo, R.C.; Parks, L.A.; Tabor, S.L. 1977.

In Physics Division annual review, 1 April 1976—31 March 1977.

The new isotope ^{57}Cr was produced by means of the ^{48}Ca(^{11}B,pn) reaction. A half-life of 21.1 +- 1.0 s was found, its

decay scheme is shown. The isotope ^{60}Mn, observed following bombardment of ^{48}Ca by ^{18}O, has a half-life of 1.8 +- 0.1 s and a 3^+ ground state; the decay scheme is shown. The isotope ^{67}As (half-life, 42.4 +- 1.2 s) was produced; measurement of its decay scheme enabled construction of a level scheme for ^{67}Ge. ^{67}Ge was found to have a mass excess of -62.666 +- 0.012 MeV and an isomeric state at 18.3 keV of 17.9 μs mean life; the K-shell conversion coefficient of 176 +- 29 for the isomeric transition establishes it almost certainly as E2.

ENERGY LEVELS AND TRANSITIONS

REFER ALSO TO CITATION(S) 27355

27356 (AD-A—042298) **Investigation of giant multipole resonances in medium and heavy nuclei by inelastic electron scattering. Final technical report, 15 October 1974—31 October 1976.** Buskirk, F.R. (Naval Postgraduate School, Monterey, Calif. (USA)). May 1977. 77p. (NPS—61Bs77061). NTIS PC A05/MF A01.

Giant Resonance Measurements in Medium and Heavy Nuclei by Inelastic Electron Scattering using the Naval Postgraduate School 120 MeV LINAC, included the nuclei ^{208}Pb, ^{197}Au, ^{165}Ho, ^{60}Ni, and ^{89}Y; investigations of the radiation tail; and, of the giant resonance line shape.

27357 **High-spin states in ^{64}Zn.** Wells, J.C. Jr.,; Fugate, L.G.; Sayer, R.O.; Robinson, R.L.; Kim, H.J.; Milner, W.T.; Smith, G.J.; Ronningen, R.M. (Physics Department, Tennessee Technological University, Cookeville, Tennessee 38501). *Phys. Rev., C;* **16**: No. 6, 2259-2267(Dec 1977).

Levels in ^{64}Zn have been investigated via the ^{51}V(^{16}O,p2n) reaction with E_{16} = 36—46 MeV, and via the ^{59}Co(^{7}Li,2n) reaction with E/sub 7Li/ = 18 MeV. Measurements were made of γ-ray singles and γ-γ coincidence spectra, of γ-ray angular distributions, and of Doppler broadening of γ-ray lines. Level energies, decay modes, spins and parities, γ-ray branching ratios, γ-ray radiative admixtures, and lifetimes were extracted. Lifetimes of levels were also determined by the Doppler-shift recoil-distance technique. There is a strongly excited band with the highest member observed being a 6^+ state at 3994 keV. There is some evidence for a second even-parity band and for an odd-parity band.

27358 **High-spin states in ^{70}Ge.** Robinson, R.L.; Kim, H.J.; Sayer, R.O.; Wells, J.C. Jr.; Ronningen, R.M.; Hamilton, J.H. (Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830). *Phys. Rev., C;* **16**: No. 6, 2268-2275(Dec 1977).

The high-spin states of ^{70}Ge have been studied through observation of γ rays from the reactions ^{60}Ni(^{12}C,2p) and ^{63}Cu(^{7}Li,2n). Measurements were made of the γ-ray singles and γ-γ coincidence spectra, of the γ-ray angular distributions, of the Doppler broadening for γ-ray lines, and of the γ-γ angular correlations. Level energies, spins and parities, and γ-ray radiation admixtures were extracted. There is a strongly excited yrast band with the highest number observed being an 8^+ state at 4433 keV. There is some evidence for a second even-parity band and for several odd-parity states with irregular level spacing.

NUCLEAR REACTIONS AND SCATTERING

REFER ALSO TO CITATION(S) 27323, 27332, 27353, 27356

27359 (ANL—77-60, pp 24-25) **Gamma rays from pion-induced reactions.** Jackson, H.E. (Los Alamos Scientific Lab., NM); Meyer-Schuetzmeister, L.; Schiffer, J.P. 1977.

In Physics Division annual review, 1 April 1976—31 March 1977.

Cross sections for production of A = 40 to 61 nuclei in 220-MeV π^- bombardment of ^{62}Ni are shown. Only yields for nuclides far from the target are reproduced by the intranuclear cascade model. Current understanding of the pre-equilibrium phase is inadequate. 1 figure. (RWR)

27360 (ANL—77-60, pp 25-26) **Energetic charged particle yields induced by pions on complex nuclei.** Jackson, H.E. (Los Alamos Scientific Lab., NM); Kaufman, S.B.; Meyer-Schuetzmeister, L. 1977.

In Physics Division annual review, 1 April 1976—31 March 1977.

Differential cross sections for protons produced by 220-MeV π^+ on ^{62}Ni are shown. Results with π^- are similar, but yields are only about 1/3 as much. Cross sections for producing >60-MeV protons are tabulated for 100- and 220-MeV π^+ and π^- on ^{27}Al, ^{62}Ni, and ^{181}Ta. 1 figure, 1 table. (RWR)

27361 **Anomalous optical-model potential for sub-Coulomb protons for 89 < A < 130.** Johnson, C.H.; Galonsky, A.; Kernell, R.L. (Oak Ridge National Laboratory, Oak Ridge Tennessee 37830). *Phys. Rev. Lett.;* **39**: No. 25, 1604-1607(19 Dec 1977).

The (p,n) cross sections for fourteen nuclei from A = 89 to A = 130 were measred from about 2.5 to 5.8 MeV in order to obtain total reaction cross sections. These cross sections disagree with optical-model predictions in that the predicted 3p resonance is missing near A = 105 and the peak near A = 90 is replaced by a valley. The data can be described by introducing an anomalous A dependence into the depth of he absorptive potential.

NUCLEAR PROPERTIES AND REACTIONS, A=90-149, THEORETICAL

ENERGY LEVELS AND TRANSITIONS

27362 **Statistical model radiation widths for 75 < A < 130 and the enhancement of p-wave neutron capture for A ≅ 90.** Johnson, C.H. (Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830). *Phys. Rev., C;* **16**: No. 6, 2238-2248(Dec 1977).

Statistical model calculations of radiation widths are made on the basis of the Axel-Brink hypothesis with two free parameters for the normalization and A dependence of the low-energy tail of the giant electric dipole resonance. The two parameters are adjusted to fit known radiation widths with a standard deviation of about +- 25% for s-wave neutron resonance levels in nuclei with 75 < A < 130. The resulting E1 strength functions are consistent with known values over a larger mass region for transitions to low-lying states. The M1 transitions are included. The level densities or nuclear temperatures for the analysis are deduced by fitting the backshifted Fermi-gas model to the total number of states near the ground state and to the s-wave spacings at neutron binding. The low density of levels for A ≅ 90 gives rise to statistical enhancement of p-wave relative to s-wave neutron radiative capture. The sum of calculated radiation widths for p-wave resonances plus calculated radiation widths for p-wave valency capture agree well with published experimental values.

NUCLEAR PROPERTIES AND REACTIONS, A=90-149, EXPERIMENTAL

RADIOACTIVE DECAY

27363 (IS-T—795) **Decay of mass-separated ^{122}Ag to levels in ^{122}Cd.** Shih, L.L.L. (Ames Lab., Iowa (USA)). Dec 1977. Contract W-7405-ENG-82. 55p. Dep. NTIS, PC A04/MF A01.

Thesis.

A study of gamma-ray de-excitation following the beta decay of ^{122}Ag is reported. Sources were prepared using the TRISTAN on-line isotope separator facility. Gamma-ray singles, gamma-gamma coincidence and gamma-ray multiscale measurements were made using Ge(Li) detectors. A total of 6 gamma rays were assigned to the decay of ^{122}Ag of which 5 were placed in a level scheme for ^{122}Cd consisting of 4 excited states at 569, 1329, 1368 and 1979 keV. Gamma-ray multiscale measurements confirmed that ^{122}Ag has only one isomer. The half-life value obtained was 0.48 +- 0.08 seconds. Spin and parity assignments were deduced on the basis of gamma-ray transition probabilities and beta transition log ft values. Results are compared with those from previous studies and the systematics of even-even Cd nuclei are discussed.

ENERGY LEVELS AND TRANSITIONS

REFER ALSO TO CITATION(S) 27356, 27363

27364 (ANL—77-60, pp 55-57) **Coulomb excitation experiments in ^{148}Sm, ^{150}Sm, ^{152}Sm, and ^{154}Sm.** Smither, R.K. (Argonne National Lab., IL); Bushnell, D.L.; Friedman, A.; Ahmad, I.; Raich, D. 1977.

In Physics Division annual review, 1 April 1976—31 March 1977.

A partial level scheme of ^{148}Sm as observed in Coulomb excitation experiments using a 55-MeV ^{16}O beam is shown. Relative γ intensities are indicated. 1 figure. (RWR)

27365 **Energy dependence of the ^{119}Sn(p,n)^{119}Sn(IAS) reaction.** Fitzgerald, D.H.; Greenlees, G.W.; Lilley, J.S.; Poppe, C.H.; Grimes, S.M.; Wong, C. (Department of Physics, University of Minnesota, Minneapolis, Minnesota 55455). *Phys. Rev., C;* **16**: No. 6, 2181-2192(Dec 1977).

Angular distributions for the ^{119}Sn(p,n)^{119}Sb(isobaric analog state) charge-exchange reaction have been measured at several energies between 16 and 20 MeV using both a neutron-proton coincidence method and a conventional pulsed beam time-of-flight method. The results furnish a value for the relative proton decay width of the analog of the ^{119}Sn ground state: Γ/sub p/vertical-barΓ = 0.320 +- 0.015. The data exhibit the well-known "resonancelike" behavior a few MeV above threshold. Nevertheless, excellent fits to both the magnitude and shape of $\sigma(\theta)$ are obtained with a Lane-

model-consistent optical potential, provided that the strength of the neutron absorption potential decreases smoothly in a realistic way with decreasing neutron energy. This modified neutron potential also gives improved fits to low-energy neutron elastic scattering and reaction cross section data.

27366 High resolution neutron total cross section measurement of ^{89}Y. Camarda, H.S. (Lawrence Livermore Laboratory, University of California, Livermore, California 94550). *Phys. Rev., C;* **16**: No. 5, 1803-1811(Nov 1977).

Results of a high resolution neutron time-of-flight experiment for neutron energies 27 < or = E < or = 240 keV on the target nucleus ^{89}Y (J/sup π/-) are presented. The measurement employed a 5 nsec beam burst and a 250 m flight path. A multilevel shape analysis of the data was carried out. The parities of almost all observed resonances were easily determined, and for s wave levels the J values of most resonances were obtained. It was found that the $\Sigma\Gamma^0$/sub n/ vs E plot of the l = 0, J = 1 levels exhibited a significant change in slope over the 240 keV interval, which was interpreted as evidence for a 1^- doorway state. The analysis yielded an escape width Γ/sup arrow-up/keV and a spreading width Γ/sup arrow-down/keV, with the doorway state located at a neutron energy of 70 keV. No effect attributable to nonstatistical behavior was observed in the p wave channel. Since most s and p wave levels were observed a relatively clean test could be made of the expected ratio of s to p wave level spacings. After estimating the number of missed levels (inferred through the use of the Porter-Thomas distribution), the experimental ratio of s to p wave spacings was found to be 2.74. This is in disagreement with the theoretical level density prediction of 2.06. The average s,p strength functions and level spacings are $S_0 = 0.28 \pm 0.05 \times 10^{-4}$, $S_1 = 2.64 \pm 0.03 \times 10^{-4}$, <D>/sub l/ = 4.0 keV, <D>/sub l/ = 1.46 keV.

NUCLEAR REACTIONS AND SCATTERING

REFER ALSO TO CITATION(S) 27353, 27356

NUCLEAR PROPERTIES AND REACTIONS, A=150-189, THEORETICAL

ENERGY LEVELS AND TRANSITIONS

27367 (IS-T—793) **Unified model studies of N = 84 and N = 80 nuclei.** Corrigan, T.M. (Ames Lab., Iowa (USA)). Dec 1977. Contract W-7405-ENG-82. 144p. Dep. NTIS, PC A07/MF A01.

Thesis.

The unified model which couples two valence nucleons to collective quadrupole surface vibrations is applied to the N = 84 and N = 80 nuclei which have respectively two neutrons and two neutron holes outside the closed N = 82 core. Two different interactions between these valence nucleons are considered. The first is a simple pairing interaction, and the second used matrix elements determined in a bare G matrix calculation. The simple pairing force gives much better results. A two step diagonalization is employed to treat the core and valence nucleons consistently. Up to four phonons are retained in the collective basis and the diagonalized (coupled) valence nucleon space is truncated at approximately the same energy. The experimental spectra and electromagnetic properties are well reproduced for both types of nuclei, and in the N = 84 nuclei the four phonon contribution was found to be nonnegligible. In addition, a closed form, multiplicity resolved expression for matrix elements of α (the collective surface coordinate) is presented, and a table of these values for N less than or equal to 6 is given.

27368 Description of yrast traps in ^{176}Hf. Faessler, A.; Ploszajczak, M. (Department of Physics, State University of New York, Stony Brook, New York 11794). *Phys. Rev., C;* **16**: No. 5, 2032-2038(Nov 1977).

The yrast traps in $^{176}_{72}Hf_{104}$ with angular momenta J = K = 14 to 22 are studied in a cranked Hartree-Fock-Bogoliubov approach with particle number projection before the variation of the important degrees of freedom. It is shown that the bands formed on the J = K bandheads corresponding to rotation around the prolate symetry axis intersect the ground state rotational band (K = 0) to form these yrast traps. The main reason for the low energy of the K = J bandheads is the concentration of Nilsson levels with a large angular momentum projection Ω on the symmetry axis near the Fermi surface in this nucleus.

NUCLEAR REACTIONS AND SCATTERING

27369 Long-range absorption in the heavy-ion optical potential. Baltz, A.J.; Kauffmann, S.K.; Glendenning, N.K.; Pruess, K. (Lawrence Berkeley Laboratory, University of California, Berkeley, California 94720). *Phys. Rev. Lett.;* **40**: No. 1, 20-23(2 Jan 1978).

A long-range imaginary optical potential approximating the effects of quadrupole Coulomb excitation is derived in closed form. An analytical closed form for sub-Coulomb elastic scattering is obtained by inserting this potential into a weak-absorption model.

NUCLEAR PROPERTIES AND REACTIONS, A=150-189, EXPERIMENTAL

RADIOACTIVE DECAY

27370 Shape coexistence in ^{186}Hg and the decay of ^{186}Tl. Cole, J.D.; Ramayya, A.V.; Hamilton, J.H.; Kawakami, H.; van Nooijen, B.; Nettles, W.G.; Riedinger, L.L.; Turner, F.E.; Bingham, C.R.; Carter, H.K.; Spejewski, E.H.; Mlekodaj, R.L.; Schmidt-Ott, W.D.; Zganjar, E.F.; Sastry, K.S.R.; Avignone, F.T. III; Toth, K.S.; Ijaz, M.A. (Physics Department, Vanderbilt University, Nashville, Tennessee 37235). *Phys. Rev., C;* **16**: No. 5, 2010-2018(Nov 1977).

Details of the identification of ^{186}Tl and its decay to ^{186}Hg as investigated with an isotope separator are presented. Conversion electrons, γ, γ-γ, and e-γ studies establish two bands in ^{186}Hg; one built on a near-spherical ground state and one on a more strongly deformed shape with a band head at 522 keV. The levels are discussed in the framework of recent theoretical calculations.

27371 Properties of the second K/sup π/+ band in ^{156}Gd. Collins, W.E.; Hamilton, J.H.; Lange, J.; Pinajian, J.J. (Physics Department, Vanderbilt University, Nashville, Tennessee 37235). *Phys. Rev., C;* **16**: No. 5, 2019-2026(Nov 1977).

Gamma-gamma directional correlation studies with two Ge (Li) detectors were performed on transitions in ^{156}Gd from the decay of ^{156}Eu. Seventeen correlations were measured including four one-three correlations. The 2^+-2^+/sub g/ transitions from K/sup π/+ states at 1129 and 1258 keV have strikingly different E2 admixtures of >99.7% and 12.6/sup +3.6//sub -2.8/, respectively. The results for other one-two correlations are (Eγ, I/sub i/, % admixture of the first transition): (1065, 2γ, E2 = 99.7/sup +0.3// sub -0.5/), (1154, 1, M2 = 0.01/sup +0.08//sub -0.01/), (1231, 2, M2 < 0.18), (1277, 1, M2 < 0.06), (1857, 1, σ1 > 92.7), (1877, 1, E2 = 9.3/sup +2.7//sub -2.5/), (1938, 1, E2 = 28 +- 2), (2098, 1, E2 = 68^{+9}/sub -8/), and (2181, 1, E2 = 30^{+5}/sub -4/). For the one-three correlations one obtains (Eγ, I/sub i/-I, % admixture of the first transition): (812, 1—2, E2 = 0.57/sup +0.42//sub -0.32/), (867, 1—2, M2 < 7.2), (944, 1—1, M2 < 3.8), and (970, 2—4, E2 > 98.6). The experimental branching ratios for the 1258 keV second K/sup π//sup I+/2 state are in marked disagreement with the Bohr-Mottleson predictions after corrections for the 80% M1 admixture in the 2—2 transition. The results of this work and those of previous works have been compared and the averaged results are reported in the text.

ENERGY LEVELS AND TRANSITIONS

REFER ALSO TO CITATION(S) 27356, 27370

27372 (ANL—77-60, pp 117-118) **Nuclear structure of the odd-N Sm isotopes, ^{145}Sm, ^{149}Sm, ^{151}Sm, ^{153}Sm, and ^{155}Sm.** Smither, R.K. (NRL/I.L.L., Grenoble, France); Bushnell, D.L.; Namenson, A.I. 1977.

In Physics Division annual review, 1 April 1976—31 March 1977.

Nilsson assignments are made for six identified rotational bands in ^{155}Sm. 1 figure. (RWR)

27373 E2 and E4 reduced matrix elements of $^{154\ 156\ 158\ 160}$Gd and $^{176\ 178\ 180}$Hf. Ronningen, R.M.; Hamilton, J.H.; Varnell, L.; Lange, J.; Ramayya, A.V.; Garcia-Bermudez, G.; Lourens, W.; Riedinger, L.L.; McGowan, F.K.; Stelson, P.H.; Robinson, R.L.; Ford, J.L.C. Jr. (Physics Department, Vanderbilt University, Nashville, Tennessee 37235). *Phys. Rev., C;* **16**: No. 6, 2208-2217(Dec 1977).

Coulomb excitation by ^{4}He ions was studied to deduce the electric quadrupole and hexadecapole reduced transition matrix elements of deformed gadolinium and hafnium nuclei. Our values of <0^+ parallelM (E2) parallel2^+ > for /sup 154,156,158,160/Gd are 1.962(20), 2.136(7), 2.230(12), and 2.269(14) eb. For /sup 176,178,180/Hf they are 2.281, 2.204, and 2.176 eb. The values of <0^+ parallelM (E4) parallel4^+ > for /sup 156,158,160/Gd are 0.42 +- 0.08, 0.34/sup +0.20//sub -0.22/, and 0.35/sup +0.09//sub -0.07/ eb^2. For /sup 176,178,180/Hf they are 0.26 +- 0.12, 0.23/sup +0.11//sub -0.20/, and 0.21/sup +0.11//sub -0.16/ eb^2, if positive values are taken, and -0.76 +- 0.15, -0.67 +- 0.20, and -0.65 +- 0.16 eb^2 if they are negative. We compare our measurements with other experimental values and with theoretical predictions of quadrupole and hexadecapole moments.

27374 Coulomb excitation measurements of reduced E2 and E4 transition matrix elements in $^{156\ 158}$Dy, $^{162\ 164}$Er, and ^{168}Yb. Ronningen, R.M.; Piercey, R.B.; Hamilton, J.H.; Maguire, C.F.; Ramayya, A.V.; Kawakami, H.; van Nooijen, B.; Grantham, R.S.; Dagenhart, W.K.; Riedinger, L.L. (Department of Physics, Vanderbilt Universi-

ty, Nashville, Tennessee 37235). *Phys. Rev., C;* **16**: No. 6, 2218-2222(Dec 1977).

The reduced E2 and E4 transition matrix elements were measured for /sup 156,158/Dy, /sup 162,164/Er, and ^{168}Yb via Coulomb excitation with α particles at energies below these where nuclear effects are expected to significantly contribute. Charge deformation parameters β/sup c/$_2$ and β/sup c/$_4$ were extracted from these matrix elements by assuming the charge distribution to have a deformed Fermi distribution form with quadrupole and hexadecapole components. Values of $<0^+$ parallel (E2) parallel$2^+>$ of 1.929, 2.161, 2.238, 2.341, and 2.402 eb were found for /sup 156,158/Dy, / sup 162,164/Er, and ^{168}Yb, respectively, with 9 or $\approx$1% uncertainty. The values of $<0^+$ parallelM (E4) parallel$4^+>$ for these same respective nuclei are 0.21/sup +0.16//sub -0.15/, 0.16/sup +0.10// sub -0.15/, 0.16/sup +0.14//sub -0.26/, 0.12/sup +0.12//sub -0.13/, and 0.19/sup +0.14//sub -0.19/ eb^2.

NUCLEAR REACTIONS AND SCATTERING

REFER ALSO TO CITATION(S) 27316, 27353, 27356, 27360

27375 Pion cross section measurements on aligned ^{165}Ho in the (3,3) resonance region. Fisher, T.R.; Becker, J.A.; Watson, B.A.; Marshak, H.; Burleson, G.R.; Cooper, M.D.; Hagerman, D.C.; Halpern, I.; Jakobson, M.J.; Jeppeson, R.H.; Johnson, K.F.; Knutson, L.D.; Marrs, R.E.; Meyer, H.O.; Redwine, R.P. (Lockheed Palo Alto Research Laboratory, Palo Alto, California 94304). *Phys. Rev., C;* **16**: No. 6, 2367-2375(Dec 1977).

The removal cross section σ (Ω) for the interaction of π^+ and π^- with aligned ^{165}Ho has been measured at E/sub π/165, and 240 MeV employing a single crystal holmium target with a nuclear alignment $B_2 = -0.44$. The range of Ω was from 0.05 to 0.55 sr. The data on σ (Ω) and $\Delta\sigma$ (Ω), the difference between the aligned and unaligned cross sections, are compared with the predictions of a coupled-channels optical model calculation employing parameters from recent muonic x-ray data.

NUCLEAR PROPERTIES AND REACTIONS, A=190-219, EXPERIMENTAL

ENERGY LEVELS AND TRANSITIONS

REFER ALSO TO CITATION(S) 27356, 27377, 27378

NUCLEAR REACTIONS AND SCATTERING

REFER ALSO TO CITATION(S) 27332, 27356

27376 (ANL—77-60, pp 111-113) **Distribution of M1 strength in ^{208}Pb.** Laszewski, R.M.; Holt, R.J.; Jackson, H.E. 1977.

In Physics Division annual review, 1 April 1976—31 March 1977.

Polarized neutrons from the ^{208}Pb(γ,r$_0$)^{207}Pb reaction at 7.5 to 10 MeV excitation were observed. Spectra, polarizations, and analyzing powers are shown. Resonance spins, parities, and B(Ml) are included. 1 figure. (RWR)

27377 (ORO—4043-37, pp 34-38) **Electron scattering from ^{204}Pb, ^{206}Pb, ^{207}Pb, ^{208}Pb (Bates Linac).** McCarthy, J.; Courtemanche, A.; Bubb, E.; Whitney, R.R. 1977.

In Experiments on the nuclear interactions of pions and electrons. Progress report, December 1, 1976—November 30, 1977.

The lead isotopes are measured to the maximum momentum transfer possible. Presently data have been taken at 57.5 to 258 MeV corresponding to an effective momentum transfer in the range of 0.594 to 2.033 fm^{-1}. The initial analysis was done on the elastic scattering cross sections. The strong collective levels are also examined. 3 references. (JFP)

27378 (ORO—4043-37, pp 40-45) **Electron scattering from ^{3}He and ^{4}He at high momentum transfer.** McCarthy, J.; Sick, I.; Day, D. 1977.

In Experiments on the nuclear interactions of pions and electrons. Progress report, December 1, 1976—November 30, 1977.

Elastic and inelastic electron scattering from helium isotopes is studied. The elastic scattering data were extended to a higher region of momentum transfer. These high q data are important for an understanding of the asymptotic behavior of the structure function and for the most precise quantitative study of the nuclear wave function with very high spatial resolution. Additional information is expected to be provided on the failure of microscopic calculation to understand the existing data near $q^2 = 0.8$ GeV^2/c^2. Preliminary charge form factors are considered. A striking result is that the best N-N potentials cannot reproduce the central depression found in the experimental results. It seems clear that these measurements supply relatively unambiguous information about the short-range behavior of the nuclear force. 8 references. (JFP)

27379 Pre-equilibrium α emission in reactions of 724-MeV ^{86}Kr with Au: A coincidence study of direct and evaporation mechanisms. Miller, J.M.; Catchen, G.L.; Logen, D.; Rajagopalan, M.; Alexander, J.M.; Kaplan, M.; Zisman, M.S. (Department of Chemistry, Columbia University, New York, New York 10027). *Phys. Rev. Lett.;* **40**: No. 2, 100-103(9 Jan 1978).

The production of ^{4}He in coincidence with a heavy fragment has been studied with a solid-state telescope and a gas telescope. For heavy fragments detected at 36° and 42°, we have mapped coincident emission of ^{4}He from 80° to 320° in the reaction plane. We find evidence for α evaporation from both fragments and for a significant number of pre-equilibrium ^{4}He particles at c.m. angles near to 90° from the detected heavy fragment with average c.m. energy of triple-prime30 MeV.

NUCLEAR PROPERTIES AND REACTIONS, A=220 AND ABOVE, THEORETICAL

SPONTANEOUS AND INDUCED FISSION

27380 Rupture of the neck in nuclear fission. Davies, K.T.R.; Managan, R.A.; Nix, J.R.; Sierk, A.J. (Physics Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830). *Phys. Rev., C;* **16**: No. 5, 1890-1901(Nov 1977).

We introduce a degree of freedom to describe the rupture of the neck in nuclear fission and calculate the point at which the neck ruptures as the nucleus descends dynamically from its fission saddle point. This is done by mentally slicing the system into two portions at its minimum neck radius and calculating the force required to separate the two portions while keeping their shapes fixed. This force is obtained by differentiating with respect to separation the sum of the Coulomb and nuclear interaction energies between the two portions. For nuclei throughout the Periodic Table we calculate this force along dynamical paths leading from the fission saddle point. The force is initially attractive but becomes repulsive when the neck reaches a critical size. For actinide nuclei the neck radius at which rupture occurs is about 2 fm. This increases the calculated translational kinetic energy of the fission fragments at infinity relative to that calculated for scission occurring at zero neck radius. With the effect of neck rupture taken into account, we calculate and compare with experimental results fission-fragment kinetic energies for two types of nuclear dissipation: ordinary two-body viscosity and one-body dissipation.

NUCLEAR PROPERTIES AND REACTIONS, A=220 AND ABOVE, EXPERIMENTAL

SPONTANEOUS AND INDUCED FISSION

27381 Fission of ^{240}Pu with 14.8-MeV neutrons. Nethaway, D.R.; Prindle, A.L.; Myers, W.A.; Fuqua, W.C.; Kantelo, M.V. (University of California, Lawrence Livermore Laboratory, Livermore, California 94550). *Phys. Rev., C;* **16**: No. 5, 1907-1918(Nov 1977).

We have measured the mass-yield distribution from the fission of ^{240}Pu induced by 14.8-MeV neutrons. Seventy-five fission products from ^{66}Ni to ^{169}Er were detected. From these measurements we obtained the total chain yields for 49 mass numbers and constructed the mass-yield curve. Absolute fission yields were obtained by using the ^{238}U(n,f) monitor reaction. The total yield determined from each half of the mass-yield curve is 0.984. From the agreement in these two methods we conclude that our yield determination is accurate to approximately 4%. The peak-to-valley ratio is 5.5, a significantly larger value than the ratio of 4.1 found for 14.8-MeV neutron fission of ^{239}Pu. This difference agrees with the trend noted previously for 14.8-MeV neutron fission of uranium isotopes. A number of independent fission yields were measured. Values of Z/sub p/ inferred from these yields agree with those estimated from independent-yield systematics, but are approximately 0.1 charge unit greater than predicted. Several partial isomer yields and isomer ratios were measured. These results provide additional information about the fractional production of isomeric states either directly from fission or from β decay. The absolute photon intensity for the 342-keV transition in the decay of ^{111}Ag/sup g/ was measured to be 0.0668(+-5%).

27382 Measurement of the effective widths of excited states of heavy nuclei (Z=98, 100, 102) by means of the blocking effect. Bugrov, V.N.; Kamanin, V.V.; Karamyan, S.A.; Oganesyan, Y.T.; Titirichi, M. (Joint Institute for Nuclear Research). *Sov. J. Nucl. Phys. (Engl. Transl.);* **25**: No. 4, 379-384(Apr 1977).

Experiments have been carried on observation of the blocking effect in the reactions $^{238}U(^{12}C,f)$, $^{238}U(^{16}O,f)$, $^{238}U(^{22}Ne,f)$ with use of a single crystal of UO_2. A difference in the depth of the shadow minima is observed which goes appreciably beyond the experimental errors on change of the angle between the directions of the crystallographic axis and the ion beam, corresponding to significantly greater lifetimes (at the level $\sim 5 \times 10^{-18}$ sec) of the compound nuclei with Z=98—102 than was expected on the basis of statistical model estimates. The most probable explanation of the experimental data is the assumption of a significant role of fission after evaporation of one or several neutrons.

27383 Number and spectra of neutrons for specified fragments in spontaneous fission of ^{252}Cf. Piksaikin, V.M.; D'yachenko, P.P.; Kutsaeva, L.S. (Physics and Power-Engineering Institute, Obninsk). *Sov. J. Nucl. Phys. (Engl. Transl.);* **25**: No. 4, 385-389(Apr 1977).

We report results of an experiment on measurement of the number and spectra of prompt neutrons from spontaneous fission of ^{252}Cf as a function of the mass and combined kinetic energy of the fragments. Information on the fragment masses was extracted from data on their kinetic energies measured by semiconductor detectors. A recoil-proton scintillation spectrometer was used to study the neutron spectra. Measurements were made for two angles between the line of emission of the fragments and the direction of motion of the neutrons, 8.7° and 90°. The data obtained are compared with the results of other authors and are discussed in terms of existing ideas regarding the mechanism of neutron emission.

27384 Thermal-neutron fission of ^{233}U and ^{235}U accompanied by emission of α particles at small angles to the fission axis. Andreev, V.N.; Nedopekin, V.G.; Rogov, V.I. (Institute of Theoretical and Experimental Physics, State Commission on Use of Atomic Energy). *Sov. J. Nucl. Phys. (Engl. Transl.);* **25**: No. 4, 390-393(Apr 1977).

Fission of ^{233}U and ^{235}U by thermal neutrons has been carried out under identical experimental conditions. The fission events studied were those accompanied by simultaneous emission of an α particle at an angle close to the fission axis ($<\theta^2>$/sup 1/2/=15°). For each event the kinetic energies of both fragments and the α-particle energy were measured. The mass distributions of the fragments and the average kinetic energy were obtained as a function of the mass. It was established that the yield of α particles at small angles to the fission axis is proportional to the probability of ternary fission, and not binary fission. On the basis of the existing experimental data it is concluded that α particles observed at angles $\theta \sim 0°$ to the fission axis are emitted from the space between the fragments, like the α particles observed at angles $\theta \sim 90°$.

27385 Fission of ^{240}U in the reaction $^{238}U(t,pf)$. Andreev, M.F.; Gladkov, V.V.; Zavgorodnii, V.A.; Marshalkin, V.E.; Povyshev, V.M.; Serov, V.I. *Sov. J. Nucl. Phys. (Engl. Transl.);* **25**: No. 4, 393-397(Apr 1977).

The fission probabilities and fission-fragment angular distributions have been measured for fission of ^{240}U in the reaction $^{238}U(t,pf)$ at a bombarding-triton energy of 12.70 +- 0.08 MeV. A channel analysis of the experimental data is used to determine the barrier parameters of the lower bands of transition states of the ^{240}U fissioning nucleus.

27386 Experimental investigation of spontaneously fissile isomers. Nedorezov, V.G.; Polikanov, S.M. (Nuclear Research Institute, USSR Academy of Sciences, Moscow). *Sov. J. Particles Nucl. (Engl. Transl.);* **8**: No. 2, 154-163(Mar 1977).

The review discusses the results of experiments carried out in recent years and the prospects for future research on the properties of spontaneously fissile isomers. The principal attention is devoted to effects permitting determination of the value of the equilibrium quadrupole deformation of isomeric states.

NUCLEAR THEORY

NUCLEAR STRUCTURE

27387 Matrix elements in the method of angular potential functions. Bursak, A.V.; Gorbatov, A.M.; Krylov, Y.N.; Solovei, A.B. (Kalinin State University). *Sov. J. Nucl. Phys. (Engl. Transl.);* **25**: No. 4, 401-403(Apr 1977).

A technique is developed for approximate calculation of matrix elements in the method of angular potential functions.

27388 Single-particle basis and translational invariance in microscopic nuclear calculations. Efros, V.D. (I. V. Kurchatov Institute of Atomic Energy). *Sov. J. Nucl. Phys. (Engl. Transl.);* **25**: No. 4, 484-489(Apr 1977).

An approach to solving the nuclear few-body problem is discussed which allows the use of the simple single-particle basis without violating translational invariance. A method is proposed for the practical solution of nuclear reaction problems in the single-particle basis. The method satisfies the Pauli principle and translational invariance. Calculation of the matrix elements of operators is treated.

27389 Microscopic theory of nuclear quadrupole excitations. Jolos, R.V.; Janssen, D. (Joint Institute for Nuclear Research, Dubna). *Sov. J. Particles Nucl. (Engl. Transl.);* **8**: No. 2, 138-153(Mar 1977).

The method of boson representations of fermion operators is used to obtain a closed expression for the collective quadrupole Hamiltonian of a nucleus. Some solutions of the Schroedinger equation with this collective Hamiltonian are investigated and it is shown that, in principle, the Hamiltonian describes spherical nuclei with their vibrational multiplets and deformed nuclei with rotational bands based on the vibrational states. The properties of the collective quadrupole states of a number of spherical and transition nuclei are analyzed.

NUCLEAR REACTIONS AND SCATTERING

27390 (SLAC—203) **Relativistic interactions in nuclei and the approach to scaling in deep inelastic scattering.** Schmidt, I.A. (Stanford Linear Accelerator Center, Calif. (USA)). Aug 1977. Contract EY-76-C-03-0515. 90p. Dep. NTIS, PC A05/MF A01.

A relativistic theory of the inclusive scattering of nuclei is given. The theory is applicable to meson production reactions as well as to the yields of light nuclei. A characterization of the relativistic nuclear wave function is given and its connection to the standard wave function is explicitly shown. Counting rules are derived that allow one to simply characterize the behavior of the reaction cross sections in terms of the short range behavior of the nucleon-nucleon force. Good agreement with experiment is achieved if the force is assumed to be due to the exchange of vector mesons with monopole form factors at each vertex. The predictions are successfully compared to several reactions. The theory can also be applied to electromagnetic interactions in light nuclei. Using relativistic nuclear wave functions, form factors and deep inelastic structure functions are analyzed. A simple Parton-model interpretation of the approach to scaling observed in lepton scattering off protons and deuterons is also presented. Different final state configurations are classified and their behavior predicted using quark counting rules. Good fits to the proton data are obtained. An extraction of the neutron structure function is performed by fitting the deuteron data. Several characteristics of the resulting parametrizations are shown to support the general model. Further experimental consequences are described.

27391 Field theoretic treatment of π-nuclear scattering. Miller, G.A. (Department of Physics, University of Washington, Seattle, Washington 98195). *Phys. Rev., C;* **16**: No. 6, 2325-2352(Dec 1977).

The dynamical assumption that single mesons are emitted or absorbed by nucleons is applied to π-nucleus scattering and leads to a π-nucleus Low equation. With the neglect of multinucleon currents and true meson absorption, the π-nucleus Low equation is shown to be equivalent to a linear equation of the same form as in standard theories except for a striking propagator modification arising from the energy dependence of the driving term. The use of a corresponding linear equation for π-nucleon scattering enables us to derive a field-theoretic multiple-scattering series. It is found that the propagator modification eliminates the Kisslinger singularity, reduces the Lorentz-Lorenz effect and local field corrections. The effect of true meson absorption on π-nucleus elastic scattering is also examined and found to be somewhat important at low (~ 50 MeV) energies but negligible (due to strong first-order optical absorption) for energies greater than 100 MeV.

27392 General form of the cross section of deep inelastic collisions. Dietrich, K.; Leclercq-Willain, C. (Physikdepartment of the Technische Universitaet, Munchen, 8046 Garching, James Franck Str.). *Ann. Phys. (N.Y.);* **109**: No. 1, 41-85(Nov 1977).

The general form of the energy-averaged "macroscopic" cross section for deep inelastic (DI) collisions is derived on the basis of semiclassical approximations. The amplitude for DI reactions is related to the incompletely relaxed part of the fluctuating S-matrix. The possibility of diffraction effects modifying the DI cross section is investigated. In the limit of a classical treatment of the external variables, the average DI cross section is shown to be uniquely determined by a classical distribution function.

27393 Energy dependence in heavy-ion optical-potential elastic scattering. Fuller, R.C. (Brookhaven National Laboratory, Upton, New York 11973). *Phys. Rev., C;* **16**: No. 5, 1865-1872(Nov 1977).

Energy dependence arising from the Regge-pole contribution to the heavy-ion elastic scattering amplitude is discussed. First it is shown that the pole amplitude generally does not display resonant energy dependence. Then oscillatory energy dependence of the Coulomb-removed total cross section is shown to arise from interference of the pole contribution with the Rutherford amplitude at $\theta = 0$. Finally, it is shown that fixed angle energy dependence can arise from interference involving a pole contribution.

27394 Three-body approach to the single-scattering optical potential. Tandy, P.C.; Redish, E.F.; Bolle, D. (Research School of Physical Sciences, Australian National University, Box 4 P. O., Canberra, A.C.T. 2600, Australia). *Phys. Rev., C;* **16**: No. 5, 1924-1944(Nov 1977).

We investigate the single-scattering optical potential in the multiple scattering approaches of Watson and of Kerman, McManus, and Thaler. Since the kinematics of single scattering is three body in nature, we build a three-body model of this term. This approach can include the proper kinematics for the struck nucleon, the identity of the target nucleons, and the binding interaction of the struck nucleon. Integral equations of the Faddeev type are derived for both the Watson and Kerman-McManus-Thaler single-scattering optical potentials. Unitarity relations are investigated and we observe that these relations can be expanded in order to identify the intermediate states responsible for the absorptive parts. The transition amplitudes to the inelastic states implicit in the model are extracted and evaluated. This permits one to understand the physical meaning of the imaginary part in precise terms. The same procedure is applied to the closure and impulse approximations for the single-scattering term and their implicit inelastic states and reaction amplitudes are identified. These approximations are evaluated by analyzing the inelastic data. We conclude that the impulse approximation to the Watson single-scattering term should provide the best two-body approximation to a single-scattering optical potential.

27395 Allowance for higher orders of the nuclear-surface deformation in calculations of elastic and inelastic nuclear form factors. Shebeko, A.V. (Khar'kov Physico-technical Institute, Ukrainian Academy of Sciences). *Sov. J. Nucl. Phys. (Engl. Transl.);* **25**: No. 4, 397-401(Apr 1977).

A method is proposed for calculating the elastic and inelastic (for excitation of low-lying collective nuclear states) nuclear form factors with allowance for the contribution from all orders in the nuclear-surface deformation. In the region of momentum transfers $q > 1\ F^{-1}$ the obtained results can differ appreciably from from those obtained in the first nonvanishing approximation in the nuclear deformation.

27396 Charged-particle emission accompanying muon capture by nuclei. Batusov, Y.A.; Eramzhyan, R.A. (Joint Institute for Nuclear Research, Dubna). *Sov. J. Particles Nucl. (Engl. Transl.);* **8**: No. 2, 95-105(Mar 1977).

The experimental data on the emission of charged particles when muons are captured by nuclei are systematized and considered from the theoretical point of view.

RADIATION AND SHIELDING PHYSICS

RADIATION PHYSICS

REFER ALSO TO CITATION(S) 27404

27397 (AD-A—042211) **An investigation of 10 to the 12th power w per sq cm focused reb deposition of thick aluminum targets. Interim report.** Johnson, D.J.; Nagel, D.J.; Oliphant, W.F. (Naval Research Lab., Washington, D.C. (USA)). May 1977. 21p. (NRL-MR—3521). NTIS PC A02/MF A01.

The VUV-emission from 6061-T6 aluminum targets, exposed to an intense focused electron beam, and ions accelerated to the diode potential were examined to study the electron absorption mechanism for a 1 meV electron beam with current density of MA/sq cm. The VUV -emission was observed with aluminum cathode x-ray diode operated with and without 1/2 micrometer aluminum filters and a near normal incidence grating spectrograph. Carbon ions were observed with a Thomas mass spectrograph and their charge state used to estimate the anode plasma temperature. The VUV-emission and carbon charge states observed are consistent with classical electron deposition and indicate an anode surface temperature of a few eV with the peak temperature occurring at the time of impedance collapse.

27398 (AD-A—042667) **Coupling of x-ray deposition to structural response. Final report.** Wisniewski, H.L. (Ballistic Research Labs., Aberdeen Proving Ground, Md. (USA)). Jun 1977. 67p. (BRL-MR—2761). NTIS PC A04/MF A01.

The need for a reliable and efficient method to predict the structural response of target structures to x-ray loading prompted the coupling of the x-ray deposition program, RIP, to the structural response program, PETROS 3. The RIP program predicts that material on the front face will blow-off as liquid-solid, liquid and vapor, thus delivering an impulsive load. Simultaneously a stress wave is transmitted through the residual solid material causing spallation on the back face. The RIP program was modified to provide specific output characteristics of the residual solid material namely: thickness, mean transverse velocity, and through-thickness distribution of temperature and tangential stresses which remain after the transverse elastoplastic stress waves have dissipated. The BRL version of PETROS 3 program was then modified to accept these data as initial conditions. A structural response test case was treated using both undegraded and degraded material properties, the solutions of which show a large disparity in output results.

27399 (AD-A—043502) **A boltzmann transport code for ion penetration in matter. Memorandum report.** Mueller, G.P.; Rosen, M. (Naval Research Lab., Washington, D.C. (USA)). Jul 1977. 48p. (NRL-MR—3556). NTIS PC A03/MF A01.

The Boltzmann equation for the single-particle distribution function for a heavy-ion beam penetrating matter is solved. Assume rotational and translational invariance, plane symmetry and time independence. A Hermite and Legendre polynomial expansion of the distribution function is made in the configuration and angular coordinates, respectively. A code for numerically solving the integral equations for the energy-dependent expansion coefficients has been written and solved explicitly for the case of a monoenergetic 200-keV beam of antimony ions incident on germanium. The range distribution of stopped Sb ions and the distribution of energy loss from the beam are presented.

27400 (AD-A—043807) **Energy dependent air/ground correction factors for the ATR (air transport of radiation) code. Final report.** Huszar, L.; Woolson, W.A.; Sulton, A.L. (Science Applications, Inc., La Jolla, Calif. (USA)). Aug 1977. Contract DAAD05-76-C-0761. 46p. (SAI—76-872-LJ). NTIS PC A03/MF A01.

Energy dependent air/ground correction factors were generated by the use of two-dimensional radiation transport calculations for neutrons, secondary gamma rays and prompt gamma rays. The correction factors were parameterized by least squares curve fitting techniques, and the results were incorporated into Version 4 of the ATR (Air Transport of Radiation) code to produce an ATR Version 4.1.

27401 Z^3 effect in the ionization cross section of argon by 1.2- and 2.0-MeV α particles. Miller, J.H. (Battelle Memorial Institute, Pacific Northwest Laboratory, Richland, Washington 99352). *Phys. Rev., A;* **16**: No. 6, 2478-2479(Dec 1977).

The Z^3 correction to the differential cross section for ejection of electrons from argon by α particles is estimated by adapting the theory of Ashley, Ritchie, and Brandt for the Z^3 effect on stopping power. Results are compared with the difference between cross sections for ionization by α particles and equivalent-velocity protons. For ejected electron energies between 40 and 190 eV, good agreement is obtained between the model and experiment. The model predicts a significant enhancement of the cross section for ejection of low-energy electrons by α particles which is not observed.

27402 Coherent excitation of nuclei and atoms on passing through a crystal. Effect of slowing down. Il'lna, I.L.; Okorokov, V.V.; Proshin, S.V.; Cheblukov, Y.N. (Institute of Theoretical and Experimental Physics, State Commission on Use of Atomic Energy). *Sov. J. Nucl. Phys. (Engl. Transl.);* **25**: No. 4, 426-428(Apr 1977).

We present the results of an exact numerical calculation taking into account the distorting effect of slowing down on the form of the Fourier spectrum of a finite sequence of interactions undergone by a particle passing through a crystal. The results of the calculation provide the possibility of predicting certain characteristics of the resonance dependence of coherent Coulomb excitation of atoms and nuclei passing through a crystal.

NEUTRON INTERACTIONS WITH MATTER

REFER ALSO TO CITATION(S) 26612, 27315, 27422

27403 (AD-A—042276) **Neutron dosimetry standard. Final report, 1 May 1974—30 October 1975.** Verbinski, V.V. (IRT Corp., San Diego, Calif. (USA)). 15 Mar 1977. Contract DNA001-74-C-0163. 116p. (INTEL-RT—8106-054). NTIS PC A06/MF A01.

The neutron spectrometry program described was carried out in support of a set of draft ASTM standards prescribing a standard method of measuring neutron spectra and characterizing the spectra in terms of their effectiveness in producing radiation damage in silicon. The neutron fluence is characterized in terms of phi(eq), the number of near-1-MeV neutrons required to produce the same radiation damage, and the spectral shape in terms of phi(eq)/phi, the equivalent 1-MeV fluence per unit fluence of neutrons above 0.01 MeV. Since there are no useable thresholds between 0.01 and 0.5 MeV, the spectrum is, to a large extent, indeterminate below 1 MeV. However, it was found that reactor spectra can be parameterized by fitting a 1/E tail to a fission or GODIVA-core spectrum, the fitting point being determined by the threshold-foil data. In this way, the uncertainty interval can be reduced to yield accuracies in phi(eq)/phi and phi(eq) of 5 and 10%, respectively. The program included an evaluation of many candidate methods of specifying a neutron field, a selection of the most suitable method (threshold-foil spectrometry),

a measurement of three different spectra, a comparison of the measurements with 'known' spectra to determine the accuracy of the method, a comparison of threshold-foil measurements carried out by two different laboratories to evaluate the precision of the method, a variational study to determine the factors that most sensitively impact the accuracy, and folding the spectra in with a recently claculated silicon radiation damage function D(E) to express the accuracy in terms of a single parameter phi(eq) or phi(eq)/phi.

DOSIMETRY

REFER ALSO TO CITATION(S) 27403

SOLID STATE PHYSICS

27404 Theory of radiative electron capture by channeled ions. Ulehla, M.K.V.; Davis, H.L. (Solid State Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830). *Phys. Rev., B;* **16**: No. 9, 4185-4187(1 Nov 1977).

A model recently proposed by Koyama and Ohtsuki for the radiative electron capture by ions bombarding a metal is reexamined. It is shown that the good agreement experiment and theory previously obtained with this model is erroneous.

SUPERCONDUCTIVITY

ACOUSTIC, ELECTRIC, MAGNETIC, OPTICAL, AND THERMAL PHENOMENA

REFER ALSO TO CITATION(S) 26654, 26655

27405 Theory of destruction of superconductivity by optical pumping. Elesin, V.F.; Kondrashov, V.E.; Shamraev, B.N. (Engineering-Physics Institute, Moscow). *Sov. Phys. - Solid State (Engl. Transl.);* **19**: No. 8, 1481-1482(Aug 1977).

By obtaining a numerical solution to the transport equation for nonequilibrium quasi particles, the critical field of a superconductor is determined.(AIP)

THEORETICAL PHYSICS

GENERAL AND MISCELLANEOUS

27406 Predictions of variations of the speed of light measured by stable clocks. Chiu, C.B.; Hsu, J.P.; Sherry, T.N. (Center for Particle Theory, University of Texas, Austin, Texas 78712). *Phys. Rev., D;* **16**: No. 8, 2420-2423(15 Oct 1977).

Within the framework of the special theory of relativity, we observe that the speed of light signals measured by two stable clocks is predicted to vary due to the motion of the earth.

CLASSICAL AND QUANTUM MECHANICS

REFER ALSO TO CITATION(S) 27202, 27424

27407 Problem of several delta-shell potentials in the Lippmann—Schwinger formulation. Jain, A.K.; Deb, S.K.; Shastry, C.S. (Department of Physics, Birla Institute of Technology and Science, Pilani-333031, India). *Am. J. Phys.;* **46**: No. 2, 147-151(Feb 1978).

The quantum-mechanical problem of the bound states corresponding to a sum of several delta-shell potentials is solved exactly as an illustration of the applications of the Lippmann-Schwinger formulation. We obtain the bound-state energies and illustrate their relation to the poles of the corresponding S matrix. In addition, the several-delta-shell-potentials problem also gives a good example for the study of localization of states in an elementary level, and we do this in some detail. It is found that for two well-separated delta-shell potentials, the ground state is localized in the stronger well whereas the excited state is localized in the weaker well. This result is generalized for n delta-shell potentials. A simple proof that n attractive delta-shell potentials cannot have more than n S-wave bound states is also given. Like other classical problems of quantum mechanics, namely the harmonic oscillator and the hydrogen atom, this problem of several delta-shell potentials serves as a good illustration of various physical and mathematical aspects of quantum mechanics.

27408 Positivity of an integral connected with the helium atom problem. Morgan, J.D. III. (Theoretical Chemistry Department, University of Oxford, 1 South Parks Road, Oxford OX1 3DR, England). *Am. J. Phys.;* **46**: No. 2, 180-181(Feb 1978).

A simple proof of the positivity of an integral which arose in J. H. Bartlett, Jr.'s treatment of the helium atom problem is presented. It is suggested that the technique used may have applications to similar complicated integrals.

27409 Some functional inequalities, with application to Green's function. Luttinger, J.M.; Friedberg, R. (Columbia Univ., New York). *Arch. Ration. Mech. Anal.;* **61**: No. 2, 187-195(1976).

Some elementary inequalities for functionals with functional derivatives of given sign are presented and proved. These are then applied to the study of Green's functions for diffusion processes in a medium with sources and sinks (or alternately to Green's functions for the Schroedinger operator). The resulting inequalities are shown to include as quite special cases the super- and subadditive inequalities of potential theory. One consequence of the generalization is that scattering length is also shown to have subadditive properties.

27410 Theory of analytic vectors and applications. Flato, M. (Coll. de France, Paris). pp 231-250 of Mathematical physics and physical mathematics. Maurin, K.; Raczka, R. (eds.). Boston; D. Reidel Publishing Co. (1976).

From Symposium on mathematical physics and physical mathematics; Warsaw, Poland (25 Mar 1975).

See CONF-740395—.

The most obvious physical notion connected with the so-called analytic vectors is the notion of an observable in quantum theories. One always makes an a priori assumption concerning the algebra of observables of a given physical situation; this hypothesis, however, contains an important part of the dynamics of the system. For a representation of a Lie group G on a topological vector space H, a vector h belonging to H is called analytic if the mapping from G to H which associates to every g belonging to G the vector tau(g).h is analytic. Several questions are addressed: whether, given that H_0 and H/sub int/ are both essentially self-adjoint on a given domain, H_0 + lambda H/sub int/ is also essentially self-adjoint; given a family of observables forming a basis of a representation of a real Lie algebra, find the conditions under which they come from a unitary representation of a symmetry group.

27411 Geometric quantization: an extended procedure. Gawedzki, K. (Univ., Warsaw). pp 287-292 of Mathematical physics and physical mathematics. Maurin, K.; Raczka, R. (eds.). Boston; D. Reidel Publishing Co. (1976).

From Symposium on mathematical physics and physical mathematics; Warsaw, Poland (25 Mar 1975).

See CONF-740395—.

By use of geometric quantization of symplectic manifolds one can obtain the position and momentum representations of quantum mechanics, if the polarization is generated in the proper way. A standard kernel representation is given for pseudo-differential operators which are combinations of a part at most linear in x and another one at most linear in p. This work shows how to obtain kernel representations in the case of a general polarized symplectic manifold. (RWR)

27412 Category of the CROCs and their interpretation. Piron, C. (Univ., Geneva). pp 419-429 of Mathematical physics and physical mathematics. Maurin, K.; Raczka, R. (eds.). Boston; D. Reidel Publishing Co. (1976). (In French)

From Symposium on mathematical physics and physical mathematics; Warsaw, Poland (25 Mar 1975).

See CONF-740395—.

The usefulness of introducing the idea of category in physics is taken up first. The complex Hilbert space of summable square functions over R^2 and the Schroedinger equation and a quantum system of spin $\frac{1}{2}$ in a magnetic field are considered. The category of CROCs (Canonically Relatively Orthocomplemented ensembles) is described, with examples and some important properties. Finally, their physical interpretation is taken up, including the systems of propositions, observables, and symmetries. (RWR)

RELATIVITY AND GRAVITATION

REFER ALSO TO CITATION(S) 27146

27413 Gravitational waves. Lichnerowicz, A. (College de France, Paris). pp 163-174 of Mathematical physics and physical mathematics. Maurin, K.; Raczka, R. (eds.). Boston; D. Reidel Publishing Co. (1976).

From Symposium on mathematical physics and physical mathematics; Warsaw, Poland (25 Mar 1975).

See CONF-740395—.

Recent progress of the theory of gravitational waves, mainly gravitational shock waves, is considered. A method is described which enables the synthesis of the results of various authors; some new facts appear, in particular, the connection between electromagnetic and gravitational shock waves. General considerations on gravitational radiations and waves are given first. Later sections deal with covariant differentiation and tensor distributions, singular 2-forms and double 2-forms, gravitational shock waves, propagation of the discontinuities, and electromagnetic and gravitational shock

waves. It is noted that an effective electromagnetic shock wave creates necessarily (except in a rare case) an effective gravitational shock wave and not an ordinary gravitational wave. (RWR)

STATISTICAL PHYSICS AND THERMODYNAMICS

27414 Chemical thermodynamic properties of ethylbenzene. Miller, A.; Scott, D.W. (Bartlesville Energy Research Center, Energy Research and Development Administration, Bartlesville, Oklahoma 74003). *J. Chem. Phys.;* **68**: No. 3, 1317-1319(1 Feb 1978).

Thermodynamic functions of ethylbenzene are calculated by standard methods of statistical thermodynamics. These calculations were prompted by new experimental data on ethylbenzene.(AIP)

ELECTRICITY AND MAGNETISM

27415 Impulse attenuation of waves emanating from a cylindrical cavity in anisotropic media. Schreyer, H.L. (Argonne National Lab., IL). *Int. J. Mech. Sci.;* **18**: 487-495(1976).

Closed-form solutions are given for stress waves resulting from the application of exponentially decaying pulses applied to cylindrical cavities in anisotropic media. It is shown that the initial compressive impulse may decay with range at a much smaller rate than the total impulse; consequently, such a possibility must be taken into account for the design of instruments or other imbedded objects. 8 figures.

MATHEMATICAL PHYSICS

REFER ALSO TO CITATION(S) 27302, 27305

27416 Integral representations of particular integrals of a class of inhomogeneous linear ordinary differential equations. Johnston, G.L. (Lawrence Berkeley Laboratory, Berkeley, California 94720). *J. Math. Phys. (N.Y.);* **19**: No. 3, 635-641(Mar 1978).

A method of obtaining integral representations of particular integrals of a class of inhomogeneous second-order linear ordinary differential equations is presented. The integrands of the representations are exp[F (z;t)], where F (z;t) =z²a (t)+zb (t)+c (t), z is the independent variable of the differential equation, and a, b, and c are initially unspecified functions of the variable of integration, t. The lower limit of the contours of integration is zero. The upper limits of integration and the contours along which the integral is taken are initially unspecified. In the general class of inhomogeneous differential equations considered, the coefficients of the dependent variable and its derivatives are polynomials in z with complex constants and the homogeneous term is exp($k_2z^2+k_1z+k_0$), where the k/sub n/ are complex constants. One imposes the conditions that the application of the homogeneous operator to the assumed form of integral representation give the integral of -partialF/partialt, that exp[F (z;0)] be equal to the inhomogeneous term of the differential equation, and that the limit of expF as t approaches the upper limit along the contour of integration be zero. By equating coefficients of different powers of z separately to zero, one obtains a set of coupled equations for a, b, and c. The basic class of inhomogeneous differential equations to which the method is applicable is determined by requiring that a, b, and c be algebraic or elementary transcendental functions of t. The class of equations to which the method is applicable is extended to include inhomogeneous terms of the form z/sup n/exp($k_2z^2+k_1z+k_0$), where n is a positive integer, by repeated differentiation of integral representations of members of the basic class with respect to k_1, treated as a parameter. More general inhomogeneous terms may be treated by superposition and, in appropriate cases, by approximation in terms of sets of orthogonal functions.

27417 Nonlinear wave and soliton propagation in media with arbitrary inhomogeneities. Chen, H.H.; Liu, C.S. (Department of Physics and Astronomy, University of Maryland, College Park, Maryland 20742). *Phys. Fluids;* **21**: No. 3, 377-380(Mar 1978).

Asymptotic solutions of nonlinear wave propagation in media with gentle, but otherwise arbitrary density inhomogeneities, are discussed. In the adiabatic approximation, a nonlinear Schroedinger equation is derived for media with linear, but time-dependent density gradients. The resulting extra term can be eliminated by going to an accelerated reference frame, which makes this modified nonlinear Schroedinger equation completely integrable by the inverse scattering method. Multi-solitons are therefore still the asymptotic states of waves propagating in media with arbitrary inhomogeneities.

27418 Field theory. Nagata, M. New York; Marcel Dekker, Inc. (1977). 276p. .

Preliminaries are given on groups and rings, and subsequent discussion focuses on some important topics on fields, such as algebraic and transcendental extensions, valuations, ordered fields, and Galois theory of algebraic extensions. (JFP)

27419 Mathematical physics and physical mathematics. Maurin, K.; Raczka, R. (eds.). Boston; D. Reidel Publishing Co. (1976). 520p. (In English and French). (CONF-740395—). .

From Symposium on mathematical physics and physical mathematics; Warsaw, Poland (25 Mar 1975).

A separate abstract was prepared for 27 of the papers in this volume. The final one, on relativistic quantum statistical mechanics, was not within the subject scope of ERA. (RWR)

27420 Some ad-hoc techniques for nonlinear partial differential equations. Ames, W.F. (Georgia Inst. of Tech., Atlanta). pp 99-134 of Mathematical physics and physical mathematics. Maurin, K.; Raczka, R. (eds.). Boston; D. Reidel Publishing Co. (1976).

From Symposium on mathematical physics and physical mathematics; Warsaw, Poland (25 Mar 1975).

See CONF-740395—.

Considerable information has been extracted from nonlinear partial differential equations by utilizing special procedures, here called ad hoc methods. These methods are categorized as follows: separation and generalizations (simple separation, implicit separation, invariant solutions by separation of variables), progressing waves and generalizations (explicit progressing waves, generalized explicit progressing waves, implicit progressing waves), miscellaneous results (assumed solution structure, dependent variable relationships), transformations (Kirchhoff's transformation, von Mises transformation, quasi-linear hyperbolic equations, contact transformations--Lagrange—Legendre and Baecklund transformations, transformations of the boundary-layer equations, miscellaneous), equations with "built in" solutions, splitting (splitting principle a la Ames, splitting principle a la Yanenko), invariant (similar) solutions via groups, and nonlinear superposition. Reference is made to a number of applications including plasma, diffusion, wave propagation, the sine-Gordon equation, fluid flow, etc. 135 references. (RWR)

27421 Some recent results in bifurcation theory. Zeidler, E. (Karl-Marx-Univ., Leipzig). pp 185-202 of Mathematical physics and physical mathematics. Maurin, K.; Raczka, R. (eds.). Boston; D. Reidel Publishing Co. (1976).

From Symposium on mathematical physics and physical mathematics; Warsaw, Poland (25 Mar 1975).

See CONF-740395—.

A short account is given of some recent results on bifurcation theory, which plays an important role in modern nonlinear functional analysis. Problems connected with eigenfunctions of nonlinear operators are studied. Let X be a real Banach space. The equation studied is $\mu(Lx + Nx) = x$, where x (not = 0) is an element of X, L is a linear continuous operator, $N : X \to X$ is a nonlinear continuous operator, norm(Nx)/norm(x) $\to$ 0 as $x \to 0$, and μ is a real parameter. A solution to this equation is desired. Nonlinear eigenvalue problems occur in many areas of physics, such as neutron transport, ambi-polar diffusion of ions and electrons in a plasma, bifurcation problems in superconductivity, and the spectrum of the He atom. The following aspects are treated: linearization, when L + N is completely continuous and L + N is a k-set contraction; the bifurcation equation (analytic methods, topological and variational methods); the modified bifurcation equation; conditions preventing second bifurcation of branches; and bifurcation in the theory of variational inequalities. 1 figure, 68 references. (RWR)

27422 Singular perturbation method for evolution equations in Banach spaces. Mika, J. (Inst. for Nuclear Research, Warsaw). pp 263-273 of Mathematical physics and physical mathematics. Maurin, K.; Raczka, R. (eds.). Boston; D. Reidel Publishing Co. (1976).

From Symposium on mathematical physics and physical mathematics; Warsaw, Poland (25 Mar 1975).

See CONF-740395—.

The singular perturbation method is applied to linear evolution equations in Banach spaces containing a small parameter multiplying the time derivative. Outer and inner asymptotic solutions are formulated, and the sense in which they converge to the exact solution is rigorously defined. It is then shown that the sum of the two asymptotic solutions converges uniformly to the exact solution. Possible applications to various physical situations are indicated.

27423 Geometric quantization of symplectic manifolds. Simms, D.J. (Trinity Coll., Dublin). pp 275-285 of Mathematical physics and physical mathematics. Maurin, K.; Raczka, R. (eds.). Boston; D. Reidel Publishing Co. (1976).

From Symposium on mathematical physics and physical mathematics; Warsaw, Poland (25 Mar 1975).

See CONF-740395—.

The aim of the theory of geometric quantization is to study the structure of the phase space of a classical mechanical system and to devise procedures for the construction of Hilbert spaces to represent the corresponding quantum-mechanical system. In this framework it seeks to establish relations between canonical transformations on the classical phase space and operators on the Hilbert space. This article gives an account of a method developed in the context of a unified theory of representations of Lie groups. The

subject is treated under the following topics: symplectic structure on the phase space; Poisson brackets and the classical equations of motion; the classical systems of Souriau--invariance groups; connections on Hermitian line bundles; polarizations; line bundles of half-forms; quantization; and applications to such things as the Kepler problem, elementary de Sitter systems, the Schroedinger equation, and elementary relativistic classical and quantum mechanics. (RWR)

27424 Symmetries gained and lost. Thom, R. (Institut des Hautes Etudes Scientifiques, Bures-sur-Yvette, France). pp 293-320 of Mathematical physics and physical mathematics. Maurin, K.; Raczka, R. (eds.). Boston; D. Reidel Publishing Co. (1976).

From Symposium on mathematical physics and physical mathematics; Warsaw, Poland (25 Mar 1975).

See CONF-740395—.

The subject of this highly mathematical work is treated under the following topics: transversality, genericity, structural stability, and all that (transversality: the implicit function theorem, generalized; stratified sets and transversal maps on them; group actions; local models for group actions); why symmetries break down (broken symmetries and resonances; nongenericity of first integrals; first integrals in Hamiltonian formalism; split system; the mean field in a space of approximate first integrals; couplings); how symmetries break down: examples in macroscopic physics (natural symmetries; the basic model: competition of singularities; competition between symmetry types); and quantum mechanics as translational symmetry breaking (the notion of local phase; competition of singularities in energy quantification). A number of natural symmetries are cited, and the competition of singularities model is illustrated with a geomorphological example. 3 figures. (RWR)

COMMUNICATION, EDUCATION, HISTORY, AND PHILOSOPHY

27425 Physics careers, employment and education (Penn State, 1977). Perl, M.L. (ed.). New York; American Institute of Physics (1978). 350p. (CONF-770861—).

From Conference on changing career opportunities in physics; University Park, PA, USA (1 Aug 1977).

The purpose of this conference on changing career opportunities for physicists was to study present and future manpower problems in the physics profession. Changes in traditional employment patterns and nontraditional employment possibilities were discussed. Responsibilities of the physics community to its new members and possible revisions of university programs and attitudes were also considered. The conference was arranged according to the following sessions: facts, myths, and projections; why things are the way they are; nonacademic careers; public policy careers for physicists; specific public sector career experiences; implementing change; and conference comments. Results of a questionnaire and a survey are included. (RWR)

FUSION ENERGY

PLASMA RESEARCH

PLASMA CONFINEMENT AND HEATING

27426 (CEA-CONF—3863) **Heating of toroidal plasmas.** Canobbio, E. (Association Euratom-CEA, Centre d'Etudes Nucleaires de Grenoble, 38 (France). Groupe de Recherches sur la Fusion Controlee; CEA Centre d'Etudes Nucleaires de Grenoble, 38 (France). Service d'Ionique Generale). 1976. 4p. (CONF-761232—7). Dep. NTIS (US Sales Only), PC A02/MF A01.

From National congress on plasma physics; Paris, France (6 Dec 1976).

The limitations of ohmic heating in achieving the thermonuclear ignition of a low-β toroidal plasma can be overcome by using several heating methods. Such methods are: fast neutral beam injection (possibly combined with an adiabatic compression or any other means) and HF heating, the most interesting schemes being based on plasma resonances. The basic physical phenomena in each method are briefly explained and results obtained are given. A new heating scheme using an outer frequency of a few kHz is described, that makes it possible to locate the exciting coils outside the vacuum vessel (some of these coils can be that producing the vertical magnetic field for the plasma equilibrium).

27427 (EUR—5602, pp 879-884) **High-temperature high-quality deuterium plasma production by laser beam(s) by means of on-line computer control technique.** Sato, K.N. (Nagoya Univ. (Japan). Inst. of Plasma Physics); Okada, S.; Kogoshi, S.; Katsurai, M.; Tanaka, H. (Tokyo Univ. (Japan)); Sekiguchi, T. (Nagoya Univ. (Japan). Inst. of Plasma Physics; Tokyo Univ. (Japan)). 1976.

From 9. symposium on fusion technology; Garmisch-Partenkirchen, F.R. Germany (14 Jun 1976).

In Proceedings of the 9. Symposium on fusion technology.

The development of a special new technique is described by which high-temperature and high-quality (fully-ionized and impurity-free) deuterium plasma may be produced within any type of magnetic bottles.

27428 (EUR-CEA-FC—886) **Eigenmode field structure of the fast magnetosonic wave in a Tokamak and loading impedance of coupling structures.** Adam, J.; Jacquinot, J. (Association Euratom-CEA, Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France). Groupe de Recherches sur la Fusion Controlee; CEA Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France). Dept. de Physique du Plasma et de la Fusion Controlee). Apr 1977. 70p. Dep. NTIS (US Sales Only), PC A04/MF A01.

Detailed calculations concerning the field structure and excitation of the fast magnetosonic wave are presented keeping in mind RF heating of a Tokamak near the ion cyclotron harmonic. The new contributions are - a discussion of the cylindrical problem in an inhomogeneous plasma including surface waves and the splitting of the eigenmodes by the poloidal field - a calculation of the field structure in the toroidal cavity resonator and the application to mode tracking - a formulation of the loading impedance of various coupling structures: array of coils in the low frequency limit or transmission lines in the high frequency case.

27429 (IAE—2520) **Neutrals escape on a wall due to charge exchange while neutral beam injection into a toroidal plasma.** Putvinskii, S.V. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow. Inst. Atomnoj Ehnergii). 1975. 15p. (In Russian). Dep. NTIS (US Sales Only), PC A02/MF A01.

The yield of the neutral particles on the chamber wall produced in the injection of a high-energy neutral-particle beam into a torodial plasma has been evaluated quantitatively. Using the Monte Carlo technique, we have calculated the trajectories of the neutrals involved in the processes of ionization and charge exchange. The method has enabled to calculate the number of neutrals escaped onto the chamber wall as a result of the charge exchange between them and the plasma ions. The numerical calculations are carried out for the parameters corresponding to the TB-0 and T-20 devices. The graphs of the number of the neutrons escaped onto chamber wall against the angle of injection of the beam, the injected beam energy and the tore radius at different plasma densities and temperatures are presented. The results of the calculations and their qualitative difference for low (20 to 40 KeV) and high (40 to 60KeV) injected beam energies are discussed.

27430 (IPPJ—252) **Possibility of medium energy neutral beam injection into stellarator reactor.** Miyamoto, K. (Nagoya Univ. (Japan). Inst. of Plasma Physics). Jun 1976. 13p. Dep. NTIS (US Sales Only), PC A02/MF A01.

The injection of neutral beam into a stellarator reactor was analyzed. The orbit of trapped particles in the helical ripples of the stellarator field was analyzed. It was examined how the trapped particles can drift into the plasma center and how the neutral beam injection with medium energy is possible to heat the center core of the plasma. At first, the field modulation of the toroidal stellarator field is described with the coordinates in the plasma cross section and the angle around the major axis of the torus. Then, the orbit of trapped particles by a helical mirror is described with the use of longitudinal invariant J, and the equations for the drift of the trapped particles are given by the first derivatives of the coordinates. It is shown that the trapped particles can escape from the helical mirror, and the escaping particles become the banana trapped by the toroidal mirror field (blocked particles) or transit particles. The velocity of the toroidal drift and the ion collision time are given as the functions of the kinetic energy of ions at the initial condition. The mean drift length is also evaluated. The energy between 80 and 100 KeV is necessary for the trapped ions to drift into the plasma center.

27431 (IPPJ—255) **Roles of turbulence on plasma heating.** Kawamura, T.; Kawabe, T. (Nagoya Univ. (Japan). Inst. of Plasma Physics). Jun 1976. 25p. Dep. NTIS (US Sales Only), PC A02/MF A01.

In this paper, the characteristic features of the turbulent heating are reviewed, which is considered to be one of the strong candidates of the further heating method in fusion reactor systems, referring to the works in the Institute of Plasma Physics, Nagoya University. The roles of turbulence in plasma heating including toroidal plasma heating are discussed from several points of view. The relation between the heating rate of plasma particles and the thermalization (randomization) frequency is theoretically investigated and the role of plasma turbulence in the fast thermalization is shown. The experimental results on fluctuation and heating of electrons and ions in turbulently heated plasmas are presented. The influence of turbulence, which is responsible for the particle heating,

on the diffusion across the confinement magnetic field is considered for the application in the toroidal plasmas. It is pointed out that the turbulent fields in the fast turbulent heating give only a minor effect to the loss of particles across the magnetic field. It can be said that the enhanced fluctuation in turbulent plasma gives its field energy to the plasma particles while it can play the role of the fast thermalization of the ordered motion of particles that is produced in the plasma by some acceleration process.

27432 (JAERI-M—6876) **Study on plasma ignition of JAERI experimental fusion reactor.** Maki, K.; Yamato, H.; Tone, T. (Japan Atomic Energy Research Inst., Tokyo). Jan 1977. 33p. (In Japanese). Dep. NTIS (US Sales Only), PC A03/MF A01.

Heating the plasma in JAERI Experimental Fusion Reactor up to the equilibrium operating state has been studied with a time dependent zero-dimensional model. The neoclassical or pseudoclassical scaling-law plays a leading part of the plasma diffusion in the low temperature region below several keV and the trapped-ion scaling-law does so in the higher region. The plasma temperature is raised to 1 keV by 10 sec Joule-heating. The plasma is heated up to the equilibrium operating state of plasma temperature 7 keV and electron density 1.1 x 10^{20} m^{-3} by 10 sec neutral beam injection heating with injection power 28 MW and fueling rate 3 x 10^{19} $m^{-3}s^{-1}$.

27433 (JAERI-M—6964) **Theoretical investigations of lower hybrid resonance heating in a tokamak.** Momota, H.; Azumi, M.; Okamoto, M.; Takizuka, T.; Fukuyama, A. (Japan Atomic Energy Research Inst., Tokyo). Mar 1977. 84p. Dep. NTIS (US Sales Only), PC A05/MF A01.

Theoretical investigations of the lower hybrid wave heating in a tokamak have been performed systematically. The requisite power for the additional heating of a large scale tokamak, JT-60, is estimated to be about 10 MW. Linear behaviour of an incident wave is extensively examined and its physical picture is clarified. The effect of toroidicity on propagation and dispersion of a lower hybrid wave is also studied. Parametric phenomena are treated without dipole approximation and the threshold in JT-60 is also examined. The formation of the high energy ion tail attributed to a high power wave is shown by theory and a good agreement with numerical calculation is obtained.

27434 (JAERI-M—6990) **Composition of neutral beam for heating JFT-2 plasma.** Shibata, T.; Itoh, T.; Shirakata, H.; Sugawara, T. (Japan Atomic Energy Research Inst., Tokyo). Feb 1977. 10p. (In Japanese). Dep. NTIS (US Sales Only), PC A02/MF A01.

The composition of neutral beam for heating the JFT-2 plasma has been measured. At 30kV acceleration and 5.5A current, power partition of the charge-exchanged and dissociated neutral hydrogen beam is 57%, 28%, 9%, 3% and 3% for H(30keV), H(15keV), H(10keV), H_2(30keV) and H_2(20keV), respectively. The gas efficiency is 57%. Impurity ion contents has also been measured without the neutralizer. The dominant impurities are oxygen and its hydrides. The amount of O^+, OH^+, H_2O^+ and H_3O^+ are about 0.4%, 0.4%, 1.3% and 0.1% of the total ion current, respectively.

27435 (ORNL/TM—6111) **Small radius start-up of tokamak plasmas with a moving limiter.** Uckan, T. (Oak Ridge National Lab., Tenn. (USA)). Dec 1977. Contract W-7405-ENG-26. 29p. Dep. NTIS, PC A03/MF A01.

The problem of start-up for a large size tokamak plasma is studied with a moving limiter. The plasma transport with the presence of the electric field diffusion and heat conduction losses is investigated analytically by the separation of variables during this early phase of the discharge. The results are then applied to a TNS-size plasma. It is shown that a moving limiter may help ameliorate the possible problem of skin effects on the current profile.

27436 (PPPL—1416) **Plasma edge cooling during RF heating.** Suckewer, S.; Hawryluk, R.J. (Princeton Univ., N.J. (USA). Plasma Physics Lab.). Jan 1978. Contract EY-76-C-02-3073. 14p. Dep. NTIS, PC A02/MF A01.

A new approach to prevent the influx of high-Z impurities into the core of a tokamak discharge by using RF power to modify the edge plasma temperature profile is presented. This concept is based on spectroscopic measurements on PLT during ohmic heating and ATC during RF heating. A one dimensional impurity transport model is used to interpret the ATC results.

27437 **Magnetohydrodynamic equilibria and local stability of axisymmetric tokamak plasmas.** Peng, Y.M.; Dory, R.A.; Nelson, D.B.; Sayer, R.O. (Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830). *Phys. Fluids;* **21**: No. 3, 467-475(Mar 1978).

The Mercier stability criterion is evaluated for various axisymmetric magnetohydrodynamic equilibria in a systematic study of the effects of shaping on the plasma critical β (volume averaged pressure over the vacuum toroidal field pressure at the center of the plasma chamber). Pressure profiles that are similar to those observed in tokamak experiments are used. Equilibrium parameters of interest are elongation, σ, and triangularity, δ, of D-shaped cross sections, aspect ratio, A, poloidal beta, β/sub p/, and pressure profile width, w/sub p/. Doublet plasmas with various σ are also included for completeness. It is shown that, for fixed plasma shapes, the critical β values increase strongly with increasing w/sub p/ (typically by a factor of roughly 4), while for fixed values of w/sub p/ the critical β values have a weaker dependence on plasma shaping (typically by a factor of roughly 2). The effectiveness of shaping (to increase β) decreases with decreasing w/sub p/, and for experimental values of w/sub p/ (9 or $\simeq$0.5) the best critical β values so determined is less than 6%. For fixed w/sub p/ in D-shaped plasmas,it is shown that the highest critical β occurs around σ=1.65 and δ=0.5. The critical β values increase strongly with decreasing A. However, if the toroidal field is fixed at the coil surface at the distance between the coils and the plasma edge is greater than half the minor radius, the highest critical pressure occurs when A> or $\simeq$3—4. The doublet plasmas considered here with σ=3 give critical β values that are similar to those of the optimal D-shaped plasmas, when identical values of w/sub p/ are used.

27438 **Intense relativistic electron beam interaction with a cool theta pinch plasma.** Hammer, D.A.; Gerber, K.A.; Dove, W.F.; Goldenbaum, G.C.; Logan, B.G.; Papadopoulos, K.; Ali, A.W. (Plasma Physics Division, Naval Research Laboratory, Washington, D. C. 20375). *Phys. Fluids;* **21**: No. 3, 483-504(Mar 1978).

Experimental results are presented for the heating of a 4 m long plasma confined by a uniform magnetic field of 4—5 kG by an intense relativistic electron beam. Beam parameters were 0.5—1 MeV, 25—80 kA, 60—70 nsec pulse duration, and electron density of 2—5 x 10^{11}/cm^3. The initial plasma density ranged from 5 x 10^{13}/cm^3 to 4 x 10^{15}/cm^3 and the electron temperature was 1—3 eV. The lower density cases were partially ionized with T/sub e/>>T/sub i/, and the higher density cases were highly ionized with T/sub e/ $\simeq$T/sub i/. In all cases, the energy coupled from the beam to the plasma was greater than can be explained by binary collisions between beam electrons and the plasma particles. Beam energy transferred to the plasma ranged from 2—7%/m, and was uniform over the 4 m length of the plasma. Over most of the density range tested, 5 x 10^{13}/cm^3 to 1.5 x 10^{15}/cm^3, the plasma heating cannot be explained by classical processes. These results are found to be explained quantitatively by the use of a full nonlinear treatment of the electron-electron two-stream instability in the kinetic regime.

27439 **Anomalous transport effects in magnetically-confined plasma columns.** Steinhauer, L. (Mathematical Sciences Northwest, Inc., Bellevue, Washington 98009). *Phys. Fluids;* **21**: No. 2, 230-236(Feb 1978).

The evolution of density structure in a magnetized plasma column is analyzed accounting for anomalous diffusion due to the lower hybrid drift instability. The plasma column is found to be divided into regions of classical, anomalous, and intermediate diffusivity. The bulk behavior, described in terms of radial confinement time, depends most sensitively upon the particle line density (ion/cm). For broad plasmas (large line density), the transport is characteristic of classical diffusion, and for slender plasmas (small line density) the transport is characteristic of anomalous diffusion. For intermediate line densities, the transport undertakes a rapid transition from classical to anomalous. Correlations between the theoretical results and past experiments are described.

27440 **Measurements of the parametric decay of CO_2-laser radiation into plasma waves at quarter-critical density using ruby-laser Thomson scattering.** Schuss, J.J.; Chu, T.K.; Johnson, L.C. (Plasma Physics Laboratory, Princeton University, Princeton, New Jersey 08540). *Phys. Rev. Lett.;* **40**: No. 1, 27-30(2 Jan 1978).

We report the results of small-angle ruby-laser Thomson-scattering measurements of the parametric excitation of plasma waves by CO_2-laser radiation at quarter-critical density in a laser-heated gas-target plasma. From supplementary data obtained from interferometry and large-angle ruby-laser scattering we infer that the threshold conditions for a convective decay are satisfied.

27441 **Electromagnetic structure resonances in inhomogeneous plasma layers.** Mayer, F.J.; Osborn, R.K.; Daniels, D.W.; McGrath, J.F. (KMS Fusion, Ann Arbor, Michigan). *Phys. Rev. Lett.;* **40**: No. 1, 30-34(2 Jan 1978).

Laser-light absorption and radiation forces are investigated for weakly collisional (ν/ω very-much-less-than 1), rigid, two-step plasma profiles in planar and spherical geometry. For the first step near critical density, the second step above critical, and appropriate step lengths, we find strong absorption even for weakly collisional plasmas. We show, however, that the radiation forces may not permit such profiles to persist in realistic, dynamic situations.

27442 **High-energy ion expansion in laser-plasma interactions.** Decoste, R.; Ripin, B.H. (University of Maryland, College Park, Maryland 20742). *Phys. Rev. Lett.;* **40**: No. 1, 34-37(2 Jan 1978).

Measurements of energetic-ion energy distributions produced from CD_2 and CH_2 targets are compared with a numerical model. The model describes the ambipolar expansion of hot electrons and

two relatively cold ion species from an electron pressure gradient. For CD_2 the plasma expansion is adequately represented by a single ion species, whereas for CH_2 two-ion fluids are required to account for the energy and the relative behavior of the high-energy ion species.

27443 Electron heat transport in a tokamak with destroyed magnetic surfaces. Rechester, A.B.; Rosenbluth, M.N. (Plasma Physics Laboratory, Princeton University, Princeton, New Jersey 08540). *Phys. Rev. Lett.;* **40**: No. 1, 38-41(2 Jan 1978).

Formulas for the electron thermal conductivity have been derived in the collisional and collisionless limits for the case of destroyed magnetic surfaces.

27444 Properties of resonantly heated electron distributions. Estabrook, K.; Kruer, W.L. (University of California, Lawrence Livermore Laboratory, Livermore, California 94550). *Phys. Rev. Lett.;* **40**: No. 1, 42-45(2 Jan 1978).

We examine in computer simulation and theory some important properties of the distributions of electrons heated by resonance absorption of intense laser light. Comparison is made with recent experiments.

27445 Analytic solutions of the two-dimensional eigenvalue problem for the trapped-electron instability in tokamaks. Tsang, K.T.; Catto, P.J. (Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830). *Phys. Rev. Lett.;* **39**: No. 26, 1664-1667(26 Dec 1977).

The radial localization of the destabilizing trapped-electron term that is caused by the differences in the pitch of the magnetic field and the mode structure is shown to result in a completely new form of the dispersion relation for the trapped-electron instability.

27446 Observation of poloidal asymmetry in impurity-ion emission due to del B drifts. Terry, J.L.; Marmar, E.S.; Chen, K.I.; Moos, W.H. (Francis Bitter National Magnet Laboratory and Plasma Fusion Center, Massachusetts Institute of Technology, Cambridge, Massachusetts 02139). *Phys. Rev. Lett.;* **39**: No. 25, 1615-1618(19 Dec 1977).

Poloidally asymmetric impurity-ion emission has been observed in high-density discharges of the Alcator Tokamak. The sense of the asymmetry reverses when the direction of the toroidal field is reversed, and all observed dependences of the strength of the asymmetry upon proton density and safety factor are consistent with the explanation that the gradient and curvature drifts of the highly collisional impurity ions cause the asymmetry. Thus the asymmetry implies that the drift is a major impurity transport process at high densities.

27447 Brillouin scatter in laser-produced plasmas. Phillion, D.W.; Kruer, W.L.; Rupert, V.C. (Lawrence Livermore Laboratory, University of California, Livermore, California 94550). *Phys. Rev. Lett.;* **39**: No. 24, 1529-1533(12 Dec 1977).

The absorption of intense laser light is found to be reduced when targets are irradiated by 1.06-μm light with long pulse widths (150—400 ps) and large focal spots (100—250 μm). Estimates of Brillouin scatter which account for the finite heat capacity of the underdense plasma predict this reduction. Spectra of the back-reflected light show red shifts indicative of Brillouin scattering.

27448 Interaction of 1.06-μm laser radiation with planar targets. Haas, R.A.; Shay, H.D.; Kruer, W.L.; Boyle, M.J.; Phillion, D.W.; Rainer, F.; Rupert, V.C.; Kornblum, H.N. (University of California Lawrence Livermore Laboratory, Livermore, California 94550). *Phys. Rev. Lett.;* **39**: No. 24, 1533-1536(12 Dec 1977).

Parylene and tungsten-glass disks have been irradiated with a 1.06-μm laser at fluxes of 10^{13}—10^{15} W/cm^2. Analysis of the experimental results indicates that the laser-plasma interaction was characterized by critical surface steepening, rippling and/or filamentation, polarization-dependent scattering, and efficient generation of superthermal electrons. These effects were signifcantly stronger in the tungsten-glass experiments.

27449 Nonlinear penetration of an inhomogeneous laser beam in an overdense plasma. Sodha, M.S.; Tripathi, V.K. (Department of Electrical Engineering, Drexel University, Philadelphia, Pennsylvania 19104). *Phys. Rev., A;* **16**: No. 5, 2101-2104(Nov 1977).

This paper presents an analysis of the penetration of an intense electromagnetic beam in an inhomogeneous plasma. It is seen that on account of the electron density gradient created by an intense transversely inhomogeneous beam a region is created in the overdense plasma where the beam can propagate. Typically a CO_2 laser beam of width $r_0 = 100$ μm, power P = 15 GW, and $\omega = 1.7 \times 10^{14}$ sec^{-1} can penetrate to a region where $\omega^2/\text{sub p}//\omega^2 = 20$ in a 500-eV inhomogeneous plasma characterized by $\omega^2/\text{sub p}//\omega^2 = (\omega^2/\text{sub p}//\omega^2)(1 + Bz)$.

27450 Ion cyclotron resonance heating in the Wisconsin supported toroidal octupole. Barter, J.D.; Sprott, J.C. (Wisconsin Univ., Madison (USA). Dept. of Physics). *Plasma Phys.;* **19**: No. 10, 945-957(Oct 1977).

Ion heating at the fundamental of the cyclotron resonance (1 MHz < approximately 2 MHz) in a toroidal octupole magnetic field is found to be in good agreement with single particle, cold plasma theory at power levels Psub(abs) < approximately 100 kW (E < approximately 100 V/m) and ion temperatures kTsub(i) < approximately 600 eV. Good penetration of the electric field is observed in the densest available plasmas (n approximately 7×10^{12} cm^{-3}) with no evidence of parametric decay or enhanced particle loss other than temperature dependent losses such as thermal flow to obstacles. Ion temperatures are limited by charge exchange on the large neutral reflux at the higher rf powers.

27451 Magnetoacoustic-heating experiments in tokamak T-4 plasma. Buzankin, V.V.; Vershkov, V.A.; Ivanov, N.V.; Kovan, I.A.; Krupin, V.A.; Popov, I.A.; Semenov, I.B.; Sokolov, Yu.A. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow. Inst. Atomnoj Ehnergii). pp 61-74 of Plasma physics and controlled nuclear fusion research 1976. Proceedings of the 6. international conference held by the IAEA at Berchtesgaden, 6-13 October 1976. Vol. 3. Vienna; IAEA (1977).

From 6. international conference on plasma physics and controlled nuclear fusion research; Berchtesgaden, F.R. Germany (6 Oct 1976).

See CONF-761012—.

Results of experiments with plasma high-frequency heating in the T-4 in the frequency range $\omega\text{sub(i)} <= \omega <= 3\omega\text{sub(i)}$ are presented. A 23-MHz fixed-frequency HF oscillator with rated power of approximately 1 MW is used to excite magnetoacoustic oscillations in the plasma. The exciter is designed as a loop uninsulated from the plasma by a dielectric which encloses the pinch and is protected by auxiliary molybdenum diaphragms on both sides. Experiments demonstrate the high electrical strength of this injection design in the absence of plasma as well as in the discharge pulse of the tokamak. The experiments are conducted in deuterium plasma containing a small admixture of hydrogen, in the density range of $5X10^{12}$ to $5X10^{13}$ cm^{-3}, with a magnetic field strength of from 10 to 35 kOe. They show that the excitation range of magnetoacoustic oscillations agrees well with the theoretical range obtained for a parabolic profile of radial plasma density distribution. When a high-frequency power of about 50 kW is injected into the plasma at the second harmonic of the deuterium ion cyclotron frequency, effective heating of the small hydrogen admixture takes place; this heating results in enriching the high-energy "tail" of the distribution function of the charge-exchange neutrals. This effect is explained by the cyclotron acceleration of the hydrogen ions in the magnetoacoustic wave field with elliptic polarization. When the HF power injected into the plasma is increased, a stripping instability develops in the form of an increase in the plasma magnetohydrodynamic activity and in the form of characteristic negative "peaks" in the discharge voltage. It is established that this instability is not the result of local action of the HF exciter and takes place only in exciting the natural magnetoacoustic oscillations of the pinch. Its occurrence is apparently not associated with the appearance of a high-energy "tail" in the plasma vessel on the ion distribution function.

27452 Plasma heating in a toroidal system by a helical quadrupole RF field with $\omega < \omega\text{sub(Bi)}$. Demirkhanov, R.A.; Kirov, A.G.; Lozovskii, S.N.; Nekrasov, F.M.; Elfimov, A.G.; Il'inskii, S.E.; Onishchenko, V.V. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Sukhumi. Fiziko-Tekhnicheskij Inst.). pp 31-36 of Plasma physics and controlled nuclear fusion research 1976. Proceedings of the 6. international conference held by the IAEA at Berchtesgaden, 6-13 October 1976. Vol. 3. Vienna; IAEA (1977).

From 6. international conference on plasma physics and controlled nuclear fusion research; Berchtesgaden, F.R. Germany (6 Oct 1976).

See CONF-761012—.

Experimental results from investigations of resonance heating on the circular two-turn stellarator R-02 over a wide range of densities ($n\text{sub(e)} = 1\text{-}5 \times 10^{13}$ cm^{-3}), constant magnetic fields ($H_0 = 6$-15kG) and RF field strengths (anti Btildephiβ approximately equal to 0-150G) by means of a helical quadrupole RF magnetic field at frequencies of $\omega < \omega\text{sub(Bi)}$ are presented in the present paper. A theroretical interpretation which assumes that this phenomenon is a twostage mechanism is given. This involves the linear resonance excitation of slightly damped natural MHD helical modes followed by the non-linear (parametric) exciation of natural volume oscillations of the plasma column. At the linear stage it is possible for the so-called 'helical resonance' to exist. This is found when the external RF field is at the same frequency as the natural helical oscillations of the plasma column (stable 'Shafranov modes'). Another possible mechanism is the so-called 'quasi-Alfven resonance' when Alfen-type waves are excited inside the plasma. It is asumed that RF energy is dissipated at the non-linear stage when slow magnetoacoustic waves are excited in the plasma as a results of parametric resonance and these effectively heat the ions as a result of ion-ion collisions or collisionless damping.

27453 Rapid further heating of tokamak plasma by fast-rising magnetic pulse. Inoue, N.; Nihei, H.; Yamazaki, K.; Ichimura, M.; Morikawa, J.; Hoshino, K.; Uchida, T. (Tokyo Univ. (Japan). Faculty of Engineering). pp 3-9 of Plasma physics and controlled nuclear fusion research 1976. Proceedings of the 6. international conference held by the IAEA at Berchtesgaden, 6-13 October 1976. Vol. 3. Vienna; IAEA (1977).

From 6. international conference on plasma physics and controlled nuclear fusion research; Berchtesgaden, F.R. Germany (6 Oct 1976).

See CONF-761012—.

The object of the experiment was to study the rapid further heating of a tokamak plasma and its influence on confinement. For this purpose, a high-voltage theta-pinch pulse was applied to a tokamak plasma and production of a high-temperature (keV) plasma was ensured within a microsecond. The magnetic pulse is applied at the plasma current maximum parallel or antiparallel to the study toroidal field. In either case, the pulsed field quickly penetrates the plasma and the plasma resistivity estimated from the penetration time is about 100 times larger than the classical. A burst of energetic neutrals of approximately 1 μs duration was observed and the energy distribution had two components of the order of 1 keV and 0.1 keV in the antiparallel case. Doppler broadening measurement shows heating of ions to a temperature higher than 200 eV; however, the line profile is not always Maxwellian distribution. The X-rays disappear at the moment of applying the magnetic pulse and reappear about 100 μs later with an intensive burst, while both energy levels are the same (approximately 100 keV).

27454 Pure-fusion and fusion-fission reactor applications of high-density linear confinement systems. Krakowski, R.A.; Miller, R.L.; Hagenson, R.L. (Los Alamos Scientific Lab., N.Mex. (USA)); Steinhauer, L.C.; Vlases, G.C.; Taussig, R.T.; Rose, P.H.; Hoffman, A.L.; Quimby, D.C.; Woodruff, G.L. pp 281-290 of Plasma physics and controlled nuclear fusion research 1976. Proceedings of the 6. international conference held by the IAEA at Berchtesgaden, 6-13 October 1976. Vol. 3. Vienna; IAEA (1977).

From 6. international conference on plasma physics and controlled nuclear fusion research; Berchtesgaden, F.R. Germany (6 Oct 1976).

See CONF-761012—.

Results are presented from systems studies and engineering designs of pure-fusion and fusion-fission (hybrid) reactors based upon high-β pulsed linear plasma confinement. In one concept, classical theta-pinch implosion heating and adiabatic compression is proposed, whereas a second approach proposes the use of intense laser light for pre-heating followed by a modest amount of adiabatic compression by the solenoidal fields. The scientific, technological, and economic potential for fusion or fusion-fission power offered by each concept is described.

27455 Summary of magnetic confinement (experiments). Pease, R.S. (UKAEA Research Group, Abingdon. Culham Lab.). pp 549-554 of Plasma physics and controlled nuclear fusion research 1976. Proceedings of the 6. international conference held by the IAEA at Berchtesgaden, 6-13 October 1976. Vol. 3. Vienna; IAEA (1977).

From 6. international conference on plasma physics and controlled nuclear fusion research; Berchtesgaden, F.R. Germany (6 Oct 1976).

See CONF-761012—.

27456 Summary of magnetic confinement (theory). Rosenbluth, M.N. (Institute for Advanced Study, Princeton, N.J. (USA)). pp 555-561 of Plasma physics and controlled nuclear fusion research 1976. Proceedings of the 6. international conference held by the IAEA at Berchtesgaden, 6-13 October 1976. Vol. 3. Vienna; IAEA (1977).

From 6. international conference on plasma physics and controlled nuclear fusion research; Berchtesgaden, F.R. Germany (6 Oct 1976).

See CONF-761012—.

27457 Dynamic characteristics of alpha-particle heating based upon the Fokker-Planck equation in D-T fusion reactor core plasmas. Saito, H.; Katsurai, M.; Tsuji, H.; Sekiguchi, T. (Department of Electrical Engineering, Univ. of Tokyo, Japan). pp 337-346 of Plasma physics and controlled nuclear fusion research 1976. Proceedings of the 6. international conference held by the IAEA at Berchtesgaden, 6-13 October 1976. Vol. 3. Vienna; IAEA (1977).

From 6. international conference on plasma physics and controlled nuclear fusion research; Berchtesgaden, F.R. Germany (6 Oct 1976).

See CONF-761012—.

The paper presents an extension of previous work on α-particle heated D-T reactor-core plasma, in which the effect of energy relaxation of α-particles (in the presence of α-particle loss) is included in a more precise manner on the basis of the Fokker-Planck equation. Two basic problems are treated in this paper: (1) the "start-up" or "ignition" problem by means of neutral-beam injection heating, and (2) the determination of α-particle energy transfer function for linear perturbations and the calculation of the growth rate of "thermal instability". Particular emphasis is laid on the discrepancies between the results of our model and those of the "instantaneous-heating model" proposed hitherto by many authors. It is found that an "inertial" property inherent in the energy distribution function of α-particles as well as a sort of "negative feedback" in the energy transfer to background electrons lead to pronounced effects on dynamics and control of α-particle-heated D-T reactors.

27458 Theory and calculations of non-magnetic dense-plasma confinement. Vekshtejn, G.E.; Mirnov, V.V.; Ryutov, D.D.; Chebotaev, P.Z. (AN SSSR, Novosibirsk. Inst. Yadernoj Fiziki). pp 535-544 of Plasma physics and controlled nuclear fusion research 1976. Proceedings of the 6. international conference held by the IAEA at Berchtesgaden, 6-13 October 1976. Vol. 3. Vienna; IAEA (1977).

From 6. international conference on plasma physics and controlled nuclear fusion research; Berchtesgaden, F.R. Germany (6 Oct 1976).

See CONF-761012—.

In the present paper, the possibility of non-magnetic confinement of a thermonuclear plasma at a temperature of T approximately 10^4eV and a density of n approximately 10^{17}-10^{18}cm^{-3} in a long cylindrical tube is considered. Non-magnetic confinement, in this case, means that the radial pressure of the plasma is balanced by the rigid walls of the tube rather than by the magnetic-field pressure (this would require a field of the order of 1MG). The role of the magnetic field only involves reducing the transverse thermal conductivity of the plasma which can be achieved with moderate magnetic fields (such that β is identical to $16\pi nT/H^2$ much>1). The characteristic features of non-magnetic confinement are clarified. These include the excitation of radial plasma flows, the formation of a dense layer of cold plasma near the walls and an increase in the part played by bremsstrahlung losses. Analytical solutions describing the behaviour of a plasma pulsed and quasi-steady-state heating by a high-current electron beam are found. The results of numerical calculations aimed at determining the parameters of a 'critical' reactor are present.

27459 Production of fast ions in laser-heated plasmas. Brueckner, K.A. (California Univ., San Diego, La Jolla (USA). Dept. of Physics); Janda, R.S. (Physical Dynamics, Inc., La Jolla, Calif., USA). *Nucl. Fusion;* **17**: No. 6, 1265-1272(1977).

The production of fast ions in laser-heated plasmas is shown to result from the large electric fields in the under-dense plasma which control the orbiting motion of super-thermal electrons produced in the processes of laser-energy absorption. The magnitude of the effect also requires that the fast electrons be reflected many times in the corona fields. The prolonged orbiting of the electrons results from the relatively high transparency of the dense plasma to the very energetic super-thermal electrons.

27460 Heating a dense theta-pinch plasma with strong fast-rising magnetic fields. Burtsev, V.A.; Berezin, A.B.; Zhukov, A.P.; Kubasov, V.A.; Lyublin, B.V.; Litunovskii, V.N.; Ovsyannikov, V.A.; Popytaev, A.N.; Smirnov, A.G.; Smirnov, V.G. (Nauchno-Issledovatel'skij Inst. Ehlektrofizicheskoj Apparatury, Leningrad (USSR)). *Nucl. Fusion;* **17**: No. 5, 887-892(1977).

Results of experimental investigations on ultra-rapid heating of a dense plasma in a linear theta-pinch and switching of megampere currents in the supply system based on the application of an inductive energy accumulation method are presented. Magnetic fields of up to 50kG with rise-times of approximately 0.2μs were generated in a solenoid 7cm in diameter and 50cm long. The following plasma parameters were obtained: nsub(e)=(2-5)X10^{16}cm^{-3}, k(Tsub(e)+Tsub(i))=1-1.5keV.

27461 Scaling laws for plasma confinement. Connor, J.W.; Taylor, J.B. (UKAEA Research Group, Abingdon. Culham Lab.). *Nucl. Fusion;* **17**: No. 5, 1047-1055(1977).

Scaling laws for plasma energy confinement must be invariant under any transformation which leaves the basic plasma equations themselves invariant. Hence, constraints can be placed on the scaling laws even though the calculation of energy loss may be quite intractable. These constraints are derived for several plasma models and shown to be characteristic of the model. Hence, in addition to reducing the number of parameters which have to be obtained empirically, these results could delineate which plasma models are appropriate for the calculation of losses. They show that the empirical scaling laws at present proposed for tokamaks are incompatible with many conventional plasma models.

27462 Approximate theory of steady-state and dynamic characteristics of alpha-particle-heated DT-fusion reactors. Saito, H.; Sekiguchi, T.; Katsurai, M. (Tokyo Univ. (Japan)); Maekawa, S. (Musashi Inst. of Tech., Tokyo (Japan)). *Nucl. Fusion;* **17**: No. 5, 919-928(1977).

The steady-state energy distribution function of alpha (α)-particles is derived in an analytical form by directly solving the Fokker-Planck (FP) equation in an approximate manner under the assumption that the functional dependence of the α-particle confinement time tausub(α)(E) on its energy is given by tausub(α)(E) approximately equal to Esup(-l)(l is a constant). In addition, a new retardation theory is proposed on the basis of the FP equation under the same assumption. Finally, this proposed retardation theory is applied to dynamic problems of an α-particle-heated DT-reactor through the introduction of what is called a "dynamic response (matrix) function", the result of which enables us to discuss quantitatively problems such as thermal instability and control without numerical analysis of the FP equation.

27463 Transient confinement of a high-density plasma in a multiple-mirror magnetic-field configuration. Tuszewski, M.; Lichtenberg, A.J.; Eylon, S. (California Univ., Berkeley (USA). Electronics Research Lab.). *Nucl. Fusion;* **17**: No. 5, 893-902(1977).

Multiple-mirror magnetic confinement is investigated experimentally with a pulsed hydrogen plasma produced by a theta-pinch source. The gun output at the end of the guide field between the theta-pinch coil and the multiple-mirror region was a sharp plasma pulse of strength approximately $10^{14}cm^{-3}$ with a ratio of drift to thermal velocity close to unity (approximately 10eV). The seven multiple-mirror cells were stabilized with a linked quadrupole field. Transient experiments were performed with hydrogen in the favourable multiple-mirror regime (n approximately $10^{13}cm^{-3}$, T approximately 10eV) where the ion mean free path is comparable to a cell length. The quadrupole field achieved partial plasma stabilization and the plasma lifetime inside the device was increased from 10-30μs in the unstabilized simple mirror geometry to 50-80μs at high values of the stabilizing current. The plasma pulse was successfully injected into the multiple-mirror region but was mainly trapped in the first half of the device, because of a non-uniform introduction region of two cells and because of the low value of the pulse drift velocity. The main features of the plasma build-up and decay were studied analytically and numerically with a simple simulation of the experiment. The numerical results were in qualitative agreement with the density profiles observed experimentally inside the device. The strong density gradients, obtained at the large values of the quadrupole current for which the flux surfaces are strongly elliptical, greatly enhanced the classical radial losses, particularly from ion-ion collisions. When included in the numerical model, the theoretical radial loss rates indicated a significant (up to 30%) decrease of the plasma lifetime inside the multiple mirror for the large values of the quadrupole current necessary for stability, in reasonable agreement with the experimental results.

27464 Neutral-injection-induced transport in mirror-confined plasmas. Woo, J.T. (Massachusetts Inst. of Tech., Cambridge (USA). Dept. of Nuclear Engineering). *Nucl. Fusion;* **17**: No. 6, 1373-1376(1977).

This paper deals with the creation and sustaining of mirror-confined hot plasma by neutral beam injection. Conditions for the build-up of a stable plasma are given.

27465 To the theory of heating of collisional plasma by means of magnetic pumping by axial-asymmetric variable fields. Lapshin, V.I. (Khar'kovskij Gosudarstvennyj Univ. (Ukrainian SSR)). *Zh. Tekh. Fiz.;* **46**: No. 2, 248-253(Feb 1976). (In Russian).

Collisional heating of an inhomogeneous plasma cylinder with the help of magnetic pumping by axial-asymmetrical alternating fields, passing along a constant magnetic field with the phase velocity ω/K_{11} exceeding or of the order of sound velocity Vsub(s), has been considered. The heating rate is found for a low-pressure magnetized plasma. It is the same by the order of magnitude as the rate of heating by axial-symmetrical fields. In the case of the acoustic resonance (ω approximately K_{11} Vsub(s)) the energy absorption rate increases by a factor of $1/\omega$tausub(i)$>>1$, provided the resonance occurs in a narrow layer, and by a factor of $1/(\omega\text{tausub(i)})^2$, provided the resonance occurs in the whole volume of plasma (tausub(i)sup(-1) is the frequency of ion-ion collisions).

27466 Endloss from a slender high-beta plasma column contained in a linear solenoid. Steinhauer, L.C. (Mathematical Sciences, Northwest, Inc., Washington (USA)). pp 351-355 of Pulsed high beta plasmas. Proceedings of the third topical conference held at UKAEA Culham Laboratory, Abingdon, Oxfordshire, UK 9-12 September 1975. Evans, D.E. (ed.). Oxford; Pergamon Press (1976).

From 3. topical conference on pulsed high beta plasmas; Abingdon, Oxfordshire, UK (9 Sep 1975).

See CONF-750944—.

Linear high-beta devices are potential fusion reactors in which a long narrow plasma is contained laterally by a vacuum magnetic field of a straight pulsed solenoid and is allowed to stream freely out at the magnet ends. The plasma is composed of a stationary central region plasma, and streaming plasma regions at each end. The present analysis determines a confinement time based on the lifetime of the central stationary plasma. This lifetime is a hybrid related to the acoustic transit time and cross-field diffusion time and differs significantly from existing theories. Its relevance to future plasma experiments and fusion reactor studies is given.

PLASMA DIAGNOSTICS

REFER ALSO TO CITATION(S) 27670, 27677

27467 (JAERI-M—6861) **Electrostatic diagnostics of JFT-2a (DIVA).** Kimura, H.; Ohtsuka, H.; Maeda, H.; Shimomura, Y.; Yamamoto, S. (Japan Atomic Energy Research Inst., Tokyo). Jan 1977. 58p. (In Japanese). Dep. NTIS (US Sales Only), PC A04/MF A01.

Electrostatic diagnostics were successfully applied in JFT-2a (DIVA) experiment to give a detailed knowledge of pertinent plasma parameters in the scrape-off layer. Ion and electron temperatures are measured with a multigrid Faraday cup; it is also useful in measuring the ion saturation current in the presence of high energy electrons. A directional probe is used in measurement of plasma flux to the divertor and also its flow velocity. The cross-field particle diffusion coefficient in the scrape-off layer is also measured. The pulsed bias method gives the ion loss flux to the shell without much disturbance of the plasma.

27468 (JAERI-M—6931) **Detection of the position and cross-section of a tokamak plasma with magnetic probes.** Aikawa, Hiroshi; Ogata, Atsushi; Suzuki, Yasuo. (Japan Atomic Energy Research Inst., Tokyo). Feb 1977. 19p. (In Japanese). Dep. NTIS (US Sales Only), PC A03/MF A01.

The position and cross-sectional shape of a Tokamak plasma are obtained analytically from magnetic probe signals, taking into consideration the toroidal effect. Multipole moment analysis of the plasma current density, introducing the vertical asymmetry, shows the horizontal and vertical displacements and the elliptical deviation. The error in the measurement is estimated by means of the least square method. The observed error is proportional to the error of setting the probes, and inversely proportional to the square root of the number of probes.

27469 (PPPL—1379) **Study of disruptive instabilities in the PLT Tokamak using x-ray techniques.** Sauthoff, N.R.; Von Goeler, S.; Stodiek, W. (Princeton Univ., N.J. (USA). Plasma Physics Lab.). Jan 1978. Contract EY-76-C-02-3073. 54p. Dep. NTIS, PC A04/MF A01.

Disruptive instabilities in PLT have been analyzed using an array of surface barrier x-ray detectors viewing the plasma cross section along 20 chords. A wide variety of phenomena have been observed. A system of classification has been attempted, based upon: (1) the severity of the disruption, (2) the dominant precursor oscillations, and (3) the location of the onset of the disruption. Minor disruptions in which the disruption does not appear at the location of the island of the precursor oscillation have been observed, sometimes accompanied by seemingly independent higher frequency oscillations of different helicity localized near the point of the disruption. Major disruptions exhibit flatter central q-profiles, slowing of the oscillations, asymmetry with respect to the center of the discharge, and a correlation with high-Z impurity radiation.

27470 (TID—27931) **TFTR diagnostic development (9C). First quarterly report, October—December 1977.** (Princeton Univ., N.J. (USA). Plasma Physics Lab.). Apr 1977. Contract EY-76-C-02-3073. 15p. Dep. NTIS, PC A02/MF A01.

This report is a collection of individual reports on progress in the development work for TFTR diagnostics in the first quarter of fiscal year 77. The reports were prepared without strict ground-rules and so are extremely uneven stylistically. Very little editing has been done. Very different amounts of man-hours have been spent on different projects which, necessarily, is reflected in statements on progress.

27471 Stark profile measurements on Lyman series lines of Al XIII. Datla, R.U.; Griem, H.R. (Department of Physics and Astronomy, University of Maryland, College Park, Maryland 20742). *Phys. Fluids;* **21**: No. 3, 505-508(Mar 1978).

Single shot photographic spectra of hydrogen-like aluminum Lyman series lines are obtained from a low inductance vacuum spark. Corresponding pinhole pictures yield information on the source size. The observed line profiles are found to increase in width along the series and the higher series members L/sub γ/and L/sub delta/ can be matched with convolved Stark and Gaussian profiles. The Gaussian profile includes the effects of source size, thermal Doppler broadening, and crystal resolution. The space and time-averaged electron density determined from the profile analysis is 2.5 x 10^{21}—1 x 10^{22} cm^{-3}.

27472 Multichannel Thomson scattering apparatus. Bretz, N.; Dimock, D.; Foote, V.; Johnson, D.; Long, D.; Tolnas, E. (Princeton University, Plasma Physics Laboratory, Princeton, New Jersey 98540). *Appl. Opt.;* **17**: No. 2, 192-202(15 Jan 1978).

A Thomson scattering apparatus for measuring the electron temperature and density along a 90-cm diam of the PLT plasma has been built. A wide angle objective images the 3-mm x 900-mm ruby laser beam onto an image dissector which rearranges the 300:1 image to 20:1 forming the input slit of a spectrometer. The stimagtic spectrometer provides twenty wavelength elements of ~76 A each. A microchannel-plate image intensifier optically coupled to a cooled SIT tube provides detection with single frame linearity and 1000:1 dynamic range. Spatial profiles of N/sub e/ and T/sub e/ in the 10^{13}—10^{14}-cm^{-3} range and 0.05—3 keV have an accuracy of 30 [10^{13}/N/sub e/ (cm^{-3})]/sup 1/2/% per 1.2-cm element.

27473 Micro-Fresnel zone plates for coded imaging applications. Ceglio, N.M.; Smith, H.I. (Lawrence Livermore Laboratory, University of California, Livermore, California 94550). *Rev. Sci. Instrum.;* **49**: No. 1, 15-20(Jan 1978).

Design considerations and fabrication procedures for Fresnel zone plates appropriate for high-resolution coded imaging of x-ray and particle emission from laser produced plasmas are presented. Fabrication results for free standing zone plate structures of high Z material (gold), large zone number (100< or =n< or =240), microscopic minimum linewidth (2.6< or =Δr< or =10.2 μm), and appreciable material thickness (1< or =t< or =7 μm) are reported.

27474 Direct measurement of compression of laser-imploded targets using x-ray spectroscopy. Yaakobi, B.; Steel, D.; Thorsos, E.; Hauer, A.; Perry, B. (Laboratory for Laser Energetics, University of Rochester, Rochester, New York 14627). *Phys. Rev. Lett.;* **39**: No. 24, 1526-1529(12 Dec 1977).

Compression of neon-filled glass microballoons irradiated by a four-beam laser system has been measured directly by Stark broadening, opacity broadening, and spatial profiles of Ne^{+9} x-ray lines. For an 8.6-atm fill pressure and a 0.2-TW, 40-psec laser pulse, the measured compressed neon density was 0.26 g/cm^3 and the product rhoR was 2.5 x 10^{-4} g/cm^2.

27475 Scattering of argon laser radiation for low-temperature plasma diagnostics. Batenin, V.M.; Pyatnitskii, L.N.; Margolin, L.Y.; Minaev, P.V. (High-Temperature Institute, Academy of Sciences of the USSR). *High Temp. (USSR) (Engl. Transl.);* **15**: No. 2, 208-213(Sep 1977).

The possibilities of using light scattering of cw gas laser radiation for low-temperature plasma diagnostics are considered. The range of parameters over which the method can be used and the required laser power are determined. An experimental arrangement is described, specifications for its units are discussed, and the preliminary results obtained by the scattering method are found to be in good agreement with spectral diagnostic data.

27476 Determination of electron density from the self-reversed deuterium D/sub b/line. Aleksandrovich, K.V.; Berezin, I.A. *Opt. Spectrosc. (USSR) (Engl. Transl.);* **43**: No. 1, 13-16(Jul 1977).

The possibility was considered of applying the self-reversed line D/sub b/deuterium for the determination of electron density n/sub e/ in a plasma of high-current pulsed discharges using Bartels' theory. The experimental values of n/sub e/, found from the self-reversed line D/sub b/agreed well with the calculated ones.

27477 Fast-electron production in laser-heated plasmas. Brueckner, K.A. (California Univ., San Diego, La Jolla (USA). Dept. of Physics). *Nucl. Fusion;* **17**: No. 6, 1257-1264(1977).

The continuum X-ray emission from laser-heated targets gives a measure of the energy deposited in superthermal electrons and an estimate of the spectrum and the average electron energy. The validity of the analysis is, however, limited by possible non-collisional energy-loss processes in the pellet corona. If this effect is ignored, fits to experimental X-ray spectra from glass microspheres at 1.06-μm laser wavelength can be readily obtained showing 15%-48% of the absorbed energy in fast electrons.

27478 Spectroscopic measurements of ion temperature in ATC tokamak with RF and neutral-beam heating. Suckewer, S.; Hinnov, E. (Princeton Univ., N.J. (USA). Plasma Physics Lab.). *Nucl. Fusion;* **17**: No. 5, 945-953(1977).

Measurements of ion temperatures in the ATC tokamak by means of Doppler broadening of various ion lines are described, and typical results presented for the various auxiliary heating experiments: compression, neutral beam, lower hybrid and ion cyclotron frequency heating. Radial resolution of the temperature measurements is achieved by utilizing spectrum lines of ions of different ionization potentials: O VII lambda 1623 A, C V lambda 2271 A and C IV lambda 1548 A, which are emitted from regions of different electron temperature. Measurement at a given radial location is performed as a function of time by repeated scanning of the line contour in times 1.5-3.0ms. The results indicate variations of heating efficiency with location and with power input level.

27479 Resolution of thin foils applicable in corpuscular plasma diagnostic. Kurnaev, V.A. (Moskovskij Inzhenerno-Fizicheskij Inst. (USSR)). *Zh. Tekh. Fiz.;* **46**: No. 3, 627-629(Mar 1976). (In Russian).

27480 Noncontact conductivity measurement. Menousek, Z. (Vysoke Uceni Technicke, Brno (Czechoslovakia). Fakulta Elektrotechnicka). pp 33-40 of Proceedings of the Conference on scientific research activities of the Technical University, Faculty of Electrical Engineering, Brno (Czechoslovakia), 15 - 17 November 1972. Gartner, O.; Liedermann, K. (eds.). Brno, Czechoslovakia; VUT Brno, Fakulta elektrotechnicka (1973). (In Czech)

From Conference on scientific research activities; Brno, Czechoslovakia (15 Nov 1972).

See CONF-721164—.

The relative change of frequency was found to be a power function of the ratio of radii of the medium and the probe with the exponent 3.2, not dependant in the given range of measurement on the specific conductivity of the medium and on the probe radius.

PLASMA KINETICS - GENERAL

27481 (AD-A—043486) **Laser heating of magnetically confined plasmas for x-ray production. Final report on phase 3.** Hoffman, A.L.; Crawford, E.A. (Mathematical Sciences Northwest, Inc., Bellevue, Wash. (USA)). Apr 1976. Contract DNA001-74-C-0006. 174p. (MSNW—76-130-1). NTIS PC A08/MF A01.

Quantitative experiments were carried out on laser heating magnetically confined neon and krypton plasma columns. Approximately 100 J in 50 nsec and up to 300 J in 500 nsec of 10.6 micrometers radiation was used to heat 5 mm diameter plasmas at 10 to the 18th power/cc electron densities to up to 200 eV electron temperatures. Intense soft radiation during the ionization process has limited heating wave propagation into the plasma column to a few centimeters, and restricted the 1 keV K-shell emission from He-like neon to several MW. A detailed hydrodynamic and atomic physics program developed for this project gives excellent agreement with the observed radiation levels. Approximately 10% conversion efficiencies of laser energies to 2 keV x-radiation are predicted at the highest conventional magnetic fields and 1 kJ laser energies.

27482 (AD-A—043571) **Plasma physics mechanisms relevant to striation structuring and decay. part 1 - aspects of striation decay. Part 2. A synopsis of drift mode behavior. Part 3. Velocity shear, the E x B instability and the k to the -2nd power density spectrum. Final report 22 December 1975—21 December 1976.** Goldman, S.R. (JAYCOR, Del Mar, Calif. (USA)). 1 Feb 1977. Contract DNA001-76-C-0186. 82p. NTIS PC A05/MF A01.

The purpose of this report is to present various factors affecting striation decay as well as to indicate their significance in terms of possible time scales for striation decay and spatial structuring of striations. In the second section mechanisms affecting sinking of ionization both parallel and perpendicular to B are presented and time scales estimated. In the third section diffusion due to one type of plasma turbulence is presented as well as ordinary collisional diffusion. Some aspects of the interplay of diffusion with spatial structure and striation evolution are shown. These are used to assess the dependence of decay on diffusion coefficient as well as to infer the possibility of plasma turbulence diffusion in observational situations. In the fourth section our results are summarized both as to decay and spatial structuring of striations.

27483 Space-time structure of neutron and X-ray sources in a plasma focus. Bostick, W.H. (Stevens Inst. of Tech., Hoboken, N.J. (USA)); Nardi, V.; Prior, W. (Istituo Elettrotecnico Nazionale Galileo Ferraris, Torino, Italy). pp 497-505 of Plasma physics and controlled nuclear fusion research 1976. Proceedings of the 6. international conference held by the IAEA at Berchtesgaden, 6-13 October 1976. Vol. 3. Vienna; IAEA (1977).

From 6. international conference on plasma physics and controlled nuclear fusion research; Berchtesgaden, F.R. Germany (6 Oct 1976).

See CONF-761012—.

Systematic measurements with paraffin collimators of the neutron emission intensity have been completed on a plasma focus with a 15-20 kV capacitor bank (hollow centre electrode; discharge period T approximately 8 μs; D_2 filling at 4-8 torr). The space resolution was 1 cm or better. These data indicate that at least 70% of the total neutron yield originates within hot-plasma regions where electron beams and high-energy D beams (approximately > 0.1-1 MeV) are produced. The neutron source is composed of several (approximately > 1-10) space-localized sources of different intensity, each with a duration approximately less than 5 ns (FWHM). Localized neutron sources and hard (approximately > 100 keV) X-ray sources have the same time multiplicity and are usually distributed in two groups over a time interval 40-400 ns long. By the mode of operation used by the authors one group of localized sources (Burst II) is observed 200-400 ns after the other group (Burst I) and its space distribution is broader than for Burst I. The maximum intensity of a localized source of neutrons in Burst I is much higher than the maximum intensity in Burst II. Secondary reactions $T(D,n)^4He$ (from the tritium produced only by primary reactions in the same discharge; no tritium was used in filling the discharge chamber) are

observed in a time coincidence with the strongest D-D neutron pulse of Burst I. The neutron signal from a localized source with high intensity has a relatively long tail of small amplitude (area tail approximately less than 0.2 X area peak). This tail can be generated by the D-D reactions of the unconfined part of an ion beam in the cold plasma. Complete elimination of scattered neutrons on the detector was achieved in these measurements.

27484 Neutron production in the dense plasma focus. Kaeppeler, H.J. (Stuttgart Univ. (TH) (Germany, F.R.). Inst. fuer Plasmaforschung). pp 437-439 of Plasma physics and controlled nuclear fusion research 1976. Proceedings of the 6. international conference held by the IAEA at Berchtesgaden, 6-13 October 1976. Vol. 3. Vienna; IAEA (1977).

From 6. international conference on plasma physics and controlled nuclear fusion research; Berchtesgaden, F.R. Germany (6 Oct 1976).

See CONF-761012—.

To analyse the phenomena in the dense plasma focus leading to neutron production, several theoretical approaches were made recently. As MHD calculations are still not capable of treating the fully compressed phase of the focus, particle calculations were carried out, showing that neutron production due to beam-beam collisions plays an essential role besides that due to beam-target collisions. These particle calculations, however, consider laminar dissipations only. To obtain a consistent theory of phenomena, however approximate, in the plasma focus, an analytical treatment was carried out, recently extended to include neutron production due to both acceleration and thermal processes. Expressions for neutron production time are given and the transfer of energy from accelerated particles to thermal distribution is discussed.

27485 Experimental verification of a theory of the current sheath in the plasma focus. Vargas, M.; Gratton, F.; Gratton, J.; Bruzzone, H.; Kelly, H. (Buenos Aires Univ. Nacional (Argentina). Facultad de Ciencias Exactas y Naturales). pp 483-487 of Plasma physics and controlled nuclear fusion research 1976. Proceedings of the 6. international conference held by the IAEA at Berchtesgaden, 6-13 October 1976. Vol. 3. Vienna; IAEA (1977).

From 6. international conference on plasma physics and controlled nuclear fusion research; Berchtesgaden, F.R. Germany (6 Oct 1976).

See CONF-761012—.

An axisymmetric model for the kinematics of the current sheath which, combined with the circuit equation, gives complete analytical solutions, was tested in a small plasma focus. Optical and electrical methods were employed to determine the shape, positions and times of the current sheath evolution. In the ordinary range of working pressures, changing the external inductance from 130 nH to 33 nH, and from statistics of a large number of shots, it was found that the theory gives a satisfactory account of the kinematical and electrical properties.

27486 Transportation of relativistic electron beam in a plasma. Iremashvili, D.V.; Timoshenko, A.P.; Udovichenko, Yu.K. *Zh. Tekh. Fiz.;* **46**: No. 2, 419-421(Feb 1976). (In Russian).

27487 Stark profiles of hydrogen lines in a plasma with a low-frequency turbulence. Oks, E.A.; Sholin, G.V. *Zh. Tekh. Fiz.;* **46**: No. 2, 254-264(Feb 1976). (In Russian).

Stark profiles of hydrogen spectral lines in a plasma with a high level of low-frequency electrostatic noises are considered. The noise spectrum is supposed to be isotropic, and the distribution of fields is predetermined in the form of convolution of the Holtsmark distribution and that of Rayleigh. Asymptotic properties of the microfield distribution in a turbulent plasma and its moments are investigated. The results of calculating the profiles of Balmer lines Hsub(α) and Hsub(β) for most important values of turbulent plasma parameters are presented.

27488 Effect of plasma on radiative sources. Verma, J.S.; Ram Chandra (Birla Inst. of Tech. and Science, Pilani (India). Dept. of Physics). pp 125-134 of Proceedings of the symposium on plasma physics and magnetohydrodynamics [held at] Bombay, February 5-6, 1975. Bombay; Department of Atomic Energy (1976).

From Symposium on plasma physics and magnetohydrodynamics; Trombay, Bombay, India (5 Feb 1975).

See CONF-750266—.

Work done on the properties of the different types of antennae immersed in or surrounded by bounded and unbounded plasmas, is reviewed. The experimental study whereever possible is reported. The possibility of constructing an electronically scannable plasma antenna system is pointed out and the scope for the further work is included.

PLASMA KINETICS - EXPERIMENTAL

27489 (EUR—5602, pp 305-310) **Technology and characteristics of breakdown and plasma in shock tube arrangements.** El-Arabaty, A.; El-Debeiky, S. (Ain Shams Univ., Cairo (Egypt)); El-Khalafawi, T.A.; Eteiba, M. (Atomic Energy Commission, Cairo (Egypt)). 1976.

From 9. symposium on fusion technology; Garmisch-Partenkirchen, F.R. Germany (14 Jun 1976).

In Proceedings of the 9. Symposium on fusion technology.

The performances of various types of discharge switches were analyzed. They have been studied as functions of the discharge voltage, the triggering voltage, gap separation as well as electrode shapes and dimensions. The high speed photographing technique has been used for studying the discharge development in the breakdown gaps of the switches. Thus, discharge switches, of the favourable shapes and dimensions and creating favourable fields to operate with minimum delay times, have been designed. Consequently, a better synchronization between the various condenser banks of the test arrangement could be achieved. Furthermore, the life times of switches could be extraordinarily lengthened.

27490 (EUR-CEA-FC—887) **Identification of Mo XV to Mo XXXIII in the soft X-ray spectrum of the TFR Tokamak.** Schwob, J.L.; Klapisch, M.; Finkenthal, M.; Schweitzer, N. (Association Euratom-CEA, Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France). Groupe de Recherches sur la Fusion Controlee; CEA Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France). Dept. de Protection). Feb 1977. 20p. Dep. NTIS (US Sales Only), PC A02/MF A01.

The spectrum of the TFR plasma was studied in the wavelength range 5A to 50A. Besides lines of C,N,O and Fe (Fe XVII to FeXXIV) many lines of highly ionized Mo atoms (Mo XV to Mo XXXIII) originating from the current - aperture limiter, were found. These lines were identified by comparison with the spectrum of a high power vacuum spark with a pure Mo or Fe anode, and with wavelength computations by means of a fully relativistic atomic model.

27491 (IPP—III/35) **Statistical distribution of high density discharges in the Pulsator Tokamak.** Lisitano, G.; Gottardi, N. (Max-Planck-Institut fuer Plasmaphysik, Garching/Muenchen (Germany, F.R.)). Jun 1977. 11p. (CONF-770906—10). Dep. NTIS (US Sales Only), PC A02/MF A01.

From 8. European conference on controlled fusion and plasma physics; Prague, Czechoslovakia (19 Sep 1977).

The experimental data reported indicate that even the small variations, from shot to shot, of the gas influx due to wall recycling lead to a deviation from the programmed discharge conditions and hence to disruption.

27492 Experimental equation of state of a highly ionized cesium plasma. Dikhter, I.Y.; Zeigarnik, V.A. (High-Temperature Institute, Academy of Sciences of the USSR). *High Temp. (USSR) (Engl. Transl.);* **15**: No. 3, 398-403(Nov 1977).

A cesium plasma was investigated by electrical explosion of wires in an argon atmosphere, at a pressure of 125—500 atm. The plasma temperature was 10,000—36,000°K and its degree of ionization varied from 0.3 to 1.5. The equation of state of an ideal, doubly ionized cesium plasma was calculated. The experimental caloric equation of state agreed satisfactorily with the theoretical equation.

27493 Some properties of the neutron yield in a low-energy plasma focus. Bruzzone, H.; Delellis, R.; Gratton, R.; Kelly, H.; Milanese, M.; Pouzo, J. (Buenos Aires Univ. Nacional (Argentina). Facultad de Ciencias Exactas y Naturales). pp 491-493 of Plasma physics and controlled nuclear fusion research 1976. Proceedings of the 6. international conference held by the IAEA at Berchtesgaden, 6-13 October 1976. Vol. 3. Vienna; IAEA (1977).

From 6. international conference on plasma physics and controlled nuclear fusion research; Berchtesgaden, F.R. Germany (6 Oct 1976).

See CONF-761012—.

The measurement is reported of the average neutron yield anti n of a low-energy plasma focus device, as a function of the filling pressure p, for three different values of the external inducatance L_0. The variation of anti n in successive shots performed with the same gas is investigated. Data on reproducibility are given.

27494 Experimental studies on generation and behaviour of field-reversing E- and P-layers. Davis, H.A.; Fleischmann, H.H.; Luckhardt, S.C.; Meger, R.A. (Cornell Univ., Ithaca, N.Y. (USA). Lab. of Plasma Studies). pp 385-393 of Plasma physics and controlled nuclear fusion research 1976. Proceedings of the 6. international conference held by the IAEA at Berchtesgaden, 6-13 October 1976. Vol. 3. Vienna; IAEA (1977).

From 6. international conference on plasma physics and controlled nuclear fusion research; Berchtesgaden, F.R. Germany (6 Oct 1976).

See CONF-761012—.

Recent results are reported from the Cornell RECE-programme studying the generation and stability of field-reversing electron and ion rings for Astron or Spherator-type devices. Most important, field-reversing electron rings with field-reversal lasting over 220 μs and overall lifetimes up to 1.3 ms were obtained in the new RECE-Christa facility using 2.5-MeV electrons. The ring decay generally is smooth and roughly consistent with a collisional diffusion of the fast electrons in the background gas, except when the toroidal field, Btheta, is permitted to decay too rapidly. Experiments on the smaller RECE-Berta facility show precessional stabilization of weak rings when magnetic multipole Ioffe fields are applied. Experiments using magnetically insulated diode arrangements and microsecond voltage pulses resulted in the generation of intense ion beams with pulse lengths up to 1 μs and current densities up to 30 Acm^{-2}.

27495 Magnetic tension and thickness in the current sheath dynamics. Gratton, F.; Vargas, M. (Buenos Aires Univ. Nacional (Argentina). Facultad de Ciencias Exactas y Naturales). pp 489-490 of Plasma physics and controlled nuclear fusion research 1976. Proceedings of the 6. international conference held by the IAEA at Berchtesgaden, 6-13 October 1976. Vienna; IAEA (1977).

From 2. conference on automated inspection and product control; Chicago, IL, USA (21 Oct 1976).

See CONF-7610125—.

A theory of the current sheath dynamics for a plasma focus including finite thickness effects is briefly communicated. Inner radial magnetic fields related to the filamentary structure are shown to be necessary for the sheath stability. The theory allows for analytic solutions in the stationary coaxial stage giving the slope and velocity of the sheath.

27496 Preliminary results of the 1-MJ plasma focus experiment. Maisonnier, C.; Rager, J.P.; Gourlan, C.; Galanti, M.; Morgan, P.D. (Comitato Nazionale per l'Energia Nucleare, Frascati (Italy). Lab. Gas Ionizzati). pp 447-453 of Plasma physics and controlled nuclear fusion research 1976. Proceedings of the 6. international conference held by the IAEA at Berchtesgaden, 6-13 October 1976. Vol. 3. Vienna; IAEA (1977).

From 6. international conference on plasma physics and controlled nuclear fusion research; Berchtesgaden, F.R. Germany (6 Oct 1976).

See CONF-761012—.

The paper describes the first year of operation with the 1-MJ Plasma Focus at Frascati. The facility, which is routinely operated at 700 kJ, has proved to be technically very reliable. Successive modifications of the two different experimental chambers (Filippov and Mather type) have led to a continuous improvement in the performance of the experiment, though the neutron yield is still a factor of ten below the value predicted by the scaling law. The role of the breakdown conditions and of the current distribution have been investigated experimentally. A critical discussion of the problems connected with the scaling of Plasma Focus experiments to high energy levels is presented.

27497 Electron cyclotron emission in ALCATOR tokamak. Hutchinson, I.H.; Komm, D.S. (Massachusetts Inst. of Tech., Cambridge (USA). National Magnet Lab.). *Nucl. Fusion;* **17**: No. 5, 1077-1084(1977).

Radial observations of emission in the vicinity of the electron cyclotron frequency and its harmonic show the radiation to be polarized; ratio of extraordinary to ordinary mode intensity of about 2:1. In the thermal spectra the effects of cold-plasma resonances upon propagation of the radiation from emission layer to observation point are evident: (i) The extraordinary mode first harmonics is always suppressed by the upper hybrid resonance layer; (ii) The ordinary-mode first harmonic is suppressed when the plasma frequency exceeds the cyclotron frequency; (iii) For sufficiently high density the second harmonic is also affected by the hybrid cut-off. In the non-thermal spectrum the broad-band emission is polarized at high frequency but not at lower. The feature in the vicinity of the plasma frequency at intermediate density is broader than previously observed and almost entirely above ωsub(pe). Internal sawtooth relaxations have been observed in the central temperature even up to peak densities of $7X10^{20}m^{-3}$. Temperature profiles deduced from second harmonic cyclotron emission and Thompson scattering data are compared.

27498 Stability of plasma column position control system. Dargeiko, M.M.; Samoilenko, Yu.I. (AN Ukrainskoj SSR, Kiev. Inst. Kibernetiki). *Ukr. Fiz. Zh. (Russ. Ed.);* **20**: No. 1, 138-142(Jan 1976). (In Russian).

Stability of the plasma column position control system is studied by a numerical method applying the Nyquist criterion. Amplitude-phase characteristics of the system are plotted, the effect of regulator's parameters on the stability is examined.

27499 Breakdown characteristics in presence of steady transverse magnetic fields. Guharay, S.K.; Gupta, S.N. (Saha Inst. of Nuclear Physics, Calcutta (India)). pp 93-99 of Proceedings of the symposium on plasma physics and magnetohydrodynamics [held at] Bombay, February 5-6, 1975. Bombay; Department of Atomic Energy (1976).

From Symposium on plasma physics and magnetohydrodynamics; Trombay, Bombay, India (5 Feb 1975).

See CONF-750266—.

Extensive studies on the breakdown characteristics of air, hydrogen and argon are being carried out in a straight cylindrical discharge tube. Investigations have been done both in the presence and in the absence of magnetic fields, in a direction transverse to the axis of the tube. Results of the experiment are presented and discussed.

PLASMA KINETICS - THEORETICAL

27500 (CEA-CONF—3859) **Plasma energy balance in PETULA experiment.** (Association Euratom-CEA, Centre d'Etudes Nucleaires de Grenoble, 38 (France). Groupe de Recherches sur la Fusion Controlee; CEA Centre d'Etudes Nucleaires de Grenoble, 38 (France). Service d'Ionique Generale). 1976. 16p. (In French). (CONF-761232—4). Dep. NTIS (US Sales Only), PC A02/MF A01.

From National congress on plasma physics; Paris, France (6 Dec 1976).

Two working regimes have been studied on the PETULA experiment: one with a tungsten limiter, the other with an alumina limiter. By investigating the electron energy balance, the 50% confinement increase obtained for the alumina case can be shown to be related to the lower level of the losses radiated by impurities, in particular oxygen the concentration of which is 3 times lower than for tungsten. A model of the ion energy balance, numerically solved, is used to simulate the ion behavior in PETULA and to evaluate the effects of T.T.M.P. heating which will be applied to the ions in 1977.

27501 (CLM-R—164) **Toroidal equilibrium of reverse field pinch.** Mohri, A. (SEE ALSO- 6413010 UKAEA Research Group, Abingdon. Culham Lab.). May 1977. 21p. Dep. NTIS (US Sales Only), PC A03/MF A01.

An analytical expression for the toroidal equilibrium of a reverse field pinch is derived in which the radial distribution of the plasma pressure is variable from a convex to a concave one near the magnetic axis. Using this expression, the marginal condition satisfying the Suydam's criterion for stability is found in the limiting case of large aspect ratio. The fraction of trapped particles in this configuration decreases near the periphery as the value of β becomes larger.

27502 (COO—2456-52) **Finite element computation of plasma equilibria.** Rivier, M. (Columbia Univ., New York (USA). School of Engineering and Applied Science). 1977. Contract EY-76--02-2456. 57p. Dep. NTIS, PC A04/MF A01.

Portions of document are illegible.

The applicability of the finite element method is investigated for the numerical solution of the nonlinear Grad-Shafranov equation with free boundary for the flux function of a plasma at equilibrium. This method is based on the case of variational principles and finite dimensional subspaces whose elements are piecewise polynomial functions obtained by a Lagrange type interpolation procedure over a triangulation of the domain. Two cases of plasma pressure (exponential and quadratic including a vacuum region) were examined. In both cases the nonuniqueness of the solutions was shown in exhibiting a deeper solution in the case of exponential pressure function, and a non-constant solution for a quadratic pressure function. In order to get this "other" solution, two linearization methods were tested with two different constraints. Different cross sections are investigated.

27503 Analysis of the Dupree-Weinstock theory of a turbulent plasma in a magnetic field. Pelletier, G.; Pomot, C. (Grenoble-1 Univ., 38 (France)). *Plasma Phys.;* **19**: No. 4, 315-328(Apr 1977). (In French).

The Dupree-Weinstock model which describes the plasma turbulence is analysed with an applied strong magnetic field. The conservation of energy and the validity of weak coupling assumption are investigated. The theory is applied to the particular case of an ion acoustic turbulence.

27504 (JAERI-M—6965) **Temperature gradient effect on impurity-ion transport.** Tuda, T. (Japan Atomic Energy Research Inst., Tokyo). Feb 1977. 24p. (In Japanese). Dep. NTIS (US Sales Only), PC A03/MF A01.

Effects of temperature gradient on the impurity transport are considered in MHD regime, taking account of the effects of the inertia of impurity ion and temperature equipartition between ions. For light impurities, the temperature equipartition effect nullifies the temperature screening term. The diffusion flux of heavy impurities largely varied in considering the ion inertia. When the host ion has a long mean free path, the impurity diffusion flux is outward when eta= d ln T sub(i)/d ln n sub(i)>0 with T sub(i) the ion temperature and n sub(i) the ion density.

27505 (JAERI-M—7019) **Dielectronic recombination of carbon, oxygen and iron in low-density and high-temperature plasmas.** Nakamura, Y.; Kasai, S.; Tazima, T. (Japan Atomic Energy Research Inst., Tokyo). Mar 1977. 45p. (In Japanese). Dep. NTIS (US Sales Only), PC A04/MF A01.

The coefficient of dielectronic recombination, which is one of the important atomic processes in tokamak plasmas, is evaluated by a semiclassical method neglecting the effects of the density and the radiation fields. Those of carbon, oxygen and iron, which play important roles in such as plasma resistivity and energy losses, are calculated numerically in the range of the electron temperature of 10 eV - 10 keV. Compared with the results obtained from Burgess equation, which is most useful for the ions with effective nuclear charge z<=20, our results show that Burgess formula is applicable for ions with z<=25 without much increase in error. Our formula obtained in the present report may be more useful for the estimation of the dielectronic recombination coefficients of ions with z>25 such as molybdenum.

27506 (LA—6824) **System of nonlinear partial differential equations describing cylindrical plasma collapse.** Carasso, A.; Suydam, B.R. (Los Alamos Scientific Lab., N.Mex. (USA)). Feb 1978. Contract W-7405-ENG-36. 30p. Dep. NTIS, PC A03/MF A01.

The snow-plough model is considered for describing cylindrical plasma collapse for a specified constant driving term. This coupled nonlinear system consists of five partial differential equations in two independent variables, one of which is the time variable. Generally, the initial value problem for similar systems is improperly posed. However, here it is shown that by direct construction of the unique solution, explicitly in terms of the initial data, the solution exists for all positive times and is generally an infinitely differentiable function of the independent variables. Nevertheless, the solution always develops a nonphysical singularity after a certain positive time, and thereafter ceases to describe the underlying physical situation. The theory leads to an a priori bound in terms of the initial data, on the time interval during which the snow-plough model is physically realistic. Several examples which illustrate the pathologies exhibited by the solution are discussed.

27507 (PPPL—1411) **Numerical calculations of transport in ALCATOR.** Hughes, M.H. (Princeton Univ., N.J. (USA). Plasma Physics Lab.). Jan 1978. Contract EY-76-C-02-3073. 34p. Dep. NTIS, PC A03/MF A01.

A simple one-dimensional transport model is described and aplied to a study of the ALCATOR Tokamak. The model assumes a neoclassical plasma but with the particle and electron thermal transport augmented by diffusion due to current driven drift waves. Neutral transport is included using a fast Monte Carlo scheme. The possibility that the trapped particle pinch effect is responsible for fueling the plasma core is investigated.

27508 **Extensions of guiding center motion to higher order.** Northrop, T.G.; Rome, J.A. (Goddard Space Flight Center, National Aeronautics and Space Adminstration, Greenbelt, Maryland 20771). *Phys. Fluids;* **21**: No. 3, 384-389(Mar 1978).

In a static magnetic field, some well-known guiding center equations maintain their form when extended to next order in gyroradius. In these cases, it is only necessary to include the next order term in the magnetic moment series. The differential equation for guiding center motion which describes both the parallel and perpendicular velocities correctly through first order in gyroradius is given. The question of how to define the guiding center position through second order arises and is discussed, and second order drifts are derived for one usual definition. The toroidal canonical angular momentum, P/sub phi/, of the guiding center in an axisymmetric field is shown to be conserved using the guiding center velocity correct through first order. When second-order motion is included, P/sub phi/ is no longer a constant. The above extensions of guiding center theory help to resolve the different tokamak orbits obtained either by using the guiding center equations of motion or by using conservation of P/sub phi/.

27509 **Renormalized dielectric function for collisionless drift wave turbulence.** Dupree, T.H.; Tetreault, D.J. (Massachusetts Institute of Technology, Cambridge, Massachusetts 02139). *Phys. Fluids;* **21**: No. 3, 425-433(Mar 1978).

Earlier renormalized theories for collisionless drift wave turbulence were deficient in several respects when $\omega < k_{\parallel} v_{i}$ and the principal perpendicular motion is the E x B drift. The earlier theories did not preserve the perpendicularity between the E x B ion current and the electric field E and consequently, did not conserve energy. In addition, earlier theories did not correctly treat the case $n_i \sim e\phi_i/T$ in which the nonlinear convective term $\tilde{\phi} \times B \times \tilde{n}_i$ should be very small. These problems are analyzed and corrected in a new version. The new theory predicts that drift wave energy is converted into parallel ion energy, producing a damping rate $\gamma_{\parallel} = -(k_{\parallel} v_{i}/\omega)^2 k_{\perp}^2 D$, where D is a test particle diffusion coefficient. For a fluctuating potential phi due only to drift waves, D is greater than zero only when the threshold $e\phi_i/T \sim (k_{\perp} L_n)^{-1}$ for ion stochastic motion is exceeded. The nonlinear stabilization will occur slightly above this threshold if $\gamma_e/\omega < (k_{\parallel} v_i/\omega)^2$ (γ_e is the linear growth rate). For this case the density diffusion coefficient D_n (which is less than D) will be $D_n \sim \gamma_e/k_{\perp}^2$.

27510 **Quasi-linear diffusion and particle transport in inhomogeneous plasmas.** Sperling, J.L. (General Atomic Company, San Diego, California 92138). *Phys. Fluids;* **21**: No. 2, 221-223(Feb 1978).

A general dispersion relation and quasi-linear diffusion operator for electrostatic turbulence in strongly magnetized but inhomogeneous plasmas are derived. Wave induced particle transport rates across the gradients and criteria for their applicability are then deduced. The theory is applied to assess enhanced transport associated with high-power lower-hybrid heating of toroidally confined plasmas.

27511 **Moment equation approach to neoclassical transport theory.** Hirshman, S.P. (Plasma Physics Laboratory, Princeton University, Princeton, New Jersey 08540). *Phys. Fluids;* **21**: No. 2, 224-229(Feb 1978).

The neoclassical cross-field fluxes for a toroidally confined, axisymmetric plasma are calculated in terms of the thermodynamic forces from the fluid continuity and momentum balance equations. This macroscopic formulation of neoclassical transport theory unifies the numerous complex expressions for the transport coefficients, previously obtained by solving the Fokker—Planck equation, and elucidates their physical basis. In the large aspect ratio limit, the continuous transition in the scaling of the diffusion coefficient throughout various collisionality regimes is shown to depend on the ratio of parallel viscosity coefficients of the plasma species. Comparison of the present results with the kinetic theory expressions for the neoclassical fluxes determines the parallel viscosity coefficients for a multispecies plasma in the long-mean-free-path regime.

27512 **Modification of Pfirsch—Schlueter transport by poloidally asymmetric sources.** Wong, S.K. (General Atomic Company, San Diego, California 92138). *Phys. Fluids;* **21**: No. 2, 299-300(Feb 1978).

Modification of particle and heat fluxes in Pfirsch—Schlueter regime due to the presence of poloidally asymmetric particle and energy sources is found for a multispecies plasma in an arbitrary axisymmetric magnetic field. The results can be obtained from those of the source-free theory via a simple substitution.

27513 **Drift-wave turbulence effects on magnetic structure and plasma transport in tokamaks.** Callen, J.D. (Oak Ridge National Laboratory, Oak Ridge Tennessee 37830). *Phys. Rev. Lett.;* **39**: No. 24, 1540-1543(12 Dec 1977).

The small magnetic perturbations accompanying drift waves are shown to produce micriscopic, fluctuating magnetic island structures and to enhance radial electron heat transport in tokamaks. The "magnetic-flutter"-induced electron heat-conduction coefficient is found to be $\chi_{e\parallel} \sim \Delta(3/16)(\nu + \gamma)\delta^2$, where δ is the magnetic island width, ν is the electron-ion collision frequency, and γ is the dirft-wave growth rate, or inverse island correlation time.

27514 **Accelerated thermalization of an inhomogeneous beam-plasma system.** Jones, R. *Plasma Phys.;* **19**: No. 10, 925-930(Oct 1977).

Consideration of the effect of plasma inhomogeneity on the beam-plasma interaction is usually restricted to increasing density in the direction of beam propagation. Such an inhomogeneity is known to be stabilizing. It is shown that negative gradients have a destabilizing effect and result in enhanced plasma heating.

27515 **Toroidal MHD stability in complex magnetic configurations.** Rizk, H.M.; Kammash, T. (Michigan Univ., Ann Arbor (USA). Dept. of Nuclear Engineering). *Plasma Phys.;* **19**: No. 10, 969-977(Oct 1977).

Mercier's localized perturbation criterion near the magnetic axis is examined for a particular type of toroidal configuration of non-planar magnetic axis of variable curvature and torsion with non-circular (elliptically and triangularly deformed) plasma cross section for the 'resonance case'. As and application, a numerical calculation is carried out for a class of equilibria that belongs to the above configuration with constant torsion. The result of the numerical calculation indicates that in the absence of longitudinal current, it is possible to have a domain of stability in a system with a horizontally elliptical (and triangular) deformation with an ellipticity corresponding to (a = 2b) i.e. the minor axis is twice the major axis. In the presence of a longitudinal current, a domain of stability is also possible and it depends on the direction of the current. In addition it is shown that horizontally elliptical and triangular deformation are favourable for stability.

27516 **Spectral-line-blending calculations applied to highly excited atomic levels in high-density argon plasmas.** Preston, R.C. (National Physical Lab., Teddington (UK)). *J. Plasma Phys.;* **10**: No. 12, 2381-2388(21 Aug 1977).

The influence of spectral-line blending, line-wing loss and self absorption on the experimental determination of the integrated intensity of various Ar I lines emitted by a homogeneous LTE plasma have been investigated using a computer-based model of the spectrum. Correction factors have been determined for the 714.7, 560.67, 614.63 and 430.01 nm lines as a function of electron density ($2 \times 10^{22} < N_{sub(e)} < 3 \times 10^{23}$ m^{-3}) and as expected have been found to be largest for lines originating from the most highly excited levels. These results appear to explain some recent experimental observations more simply than explanations in terms of high-density corrections to the Boltzmann distribution of number densities.

27517 Dynamics of a non-cylindrical Z-pinch and the particle acceleration mechanism. Vikhrev, V.V.; Gureev, K.G.; Zhdanov, S.K.; Korzhavin, V.M.; Trubnikov, B.A. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow. Inst. Atomnoj Ehnergii). pp 455-469 of Plasma physics and controlled nuclear fusion research 1976. Proceedings of the 6. international conference held by the IAEA at Berchtesgaden, 6-13 October 1976. Vol. 3. Vienna; IAEA (1977).

From 6. international conference on plasma physics and controlled nuclear fusion research; Berchtesgaden, F.R. Germany (6 Oct 1976).

See CONF-761012—.

The dynamics of a plasma in a Z-pinch is considered theoretically, and it is shown that: (1) anisotropic hydrodynamics with magnetic visconsity is a correct collisionless MHD model for the plasma; (2) this model enables the drift instability of the Z-pinch boundary which results in turbulent diffusion with the "Bohm" coefficient D approximately cT/eB to be investigated; (3) this coefficient in accordance with the formula lambda approximately $\sqrt{2}$Dt approximately $\sqrt{a/J_0}$ defines the length of the sausage-type instability which is the same as that observed; (4) as a result of the partial replacement of the conduction current by a displacement current, a wave in which the condition E>B is inevitably satisfied develops and this results in acceleration of both the ions and the electrons; (5) allowance for the Hall effect results in increased escape of plasma from the sausage-type instability; (6) transverse-current instabilities play an important part in the dynamics of the final stage of the plasma focus, and the anomalous conductivity due to these instabilities gives rise to increased heating and cessation of radial plasma confinement; (7) the neutron yield from the plasma focus may be explained quantitatively by a thermonuclear mechanism on the basis of a simple model for the development of the plasma focus.

27518 Stationary temperature profile in a tokamak reactor operated in the neoclassical regime. Volkov, T.F.; Igitkhanov, Yu.L.; Tokar, M.Z. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow. Inst. Atomnoj Ehnergii). pp 359-365 of Plasma physics and controlled nuclear fusion research 1976. Proceedings of the 6. international conference held by the IAEA at Berchtesgaden, 6-13 October 1976. Vol. 3. Vienna; IAEA (1977).

From 6. international conference on plasma physics and controlled nuclear fusion research; Berchtesgaden, F.R. Germany (6 Oct 1976).

See CONF-761012—.

It is shown that the neoclassical character of the transport processes allows operation of fusion in a regime where a zone of cold plasma capable of protecting the wall from sputtering is formed near the wall. The possibility of establishing such a regime is determined by the "impermeability" of the reactor plasma with respect to the neutral atoms.

27519 Free-boundary equilibrium computations for strongly elongated Belt Pinch plasmas. Becker, G.; Lackner, K. (Max-Planck-Institut fuer Plasmaphysik, Garching/Muenchen (Germany, F.R.)). *Nucl. Fusion;* **17**: No. 5, 903-908(1977).

A free-boundary MHD equilibrium code is used to determine the plasma shape and toroidal current distribution in highly elongated Garching Belt Pinch II equilibria (b/a=10-14). The parameters of the calculations are optimized to fit the experimental boundary conditions as well as the measured axial profiles of Bsub(z) and the values of [β] and [βsub(p)]. It is found that the plasma surfaces come close to a racetrack shape, and that the current density can be roughly described by jsub(t)=csub(op)r+csub(oF)/r for diamagnetic p!asmas and jsub(t)=csub(op)r for [βsub(p)]=1. This corresponds to extremely elongated inner flux surfaces, moderate gradients of the q profile and plasma pressure and toroidal field distributions which are almost axially homogeneous. The production and the time development of such jsub(t) profiles are discussed.

27520 Effect of current peaking on non-circular uniaxial tokamak equilibria. Berger, D.; Gruber, R.; Hofmann, F.; Nguyen, V.K. (Ecole Polytechnique Federale, Lausanne (Switzerland); Centre de Recherches en Physique des Plasmas, Lausanne (Switzerland)). *Nucl. Fusion;* **17**: No. 5, 1095-1100(1977).

27521 Transport properties of a tokamak plasma with impurities in the collision-dominated regime. Engelmann, F.; Nocentini, A. (Stichting voor Fundamenteel Onderzoek der Materie, Jutphaas (Netherlands). Instituut voor Plasma-Fysica). *Nucl. Fusion;* **17**: No. 5, 995-1000(1977).

The transport properties of an axisymmetric toroidal plasma containing an arbitrary number of impurity species are considered for the case that all species are in the collision-dominated regime. Energy transfer between the different species, and in particular between electrons and ions, is taken into account. This yields expressions for the particle and heat fluxes applicable to a wide range of parameters.

27522 Moment method for calculating the transport of energetic charged particles in hot plasmas. Haldy, P.A.; Ligou, J. (Laboratoire de Genie Atomique, Swiss Federal Inst. of Technology, Lausanne). *Nucl. Fusion;* **17**: No. 6, 1225-1235(1977).

A moment method is derived for the transport of energetic ions in an infinite homogeneous hot plasma, in the absence of electromagnetic fields. Within the framework of the continuous-slowing-down approximation, the Fokker-Planck equation is solved rigorously for plane and point sources. Angular flux and scattering anisotropy are correctly taken into account. Calculated results are presented for protons and deuterons slowing down in boron hydride plasmas for several source energies and temperatures. Comparisons with available Monte-Carlo results have been made in the case of 3.5-MeV alpha-particle transport in high-density D-T plasmas. Very good agreement has been achieved.

27523 Ignition parameter Tntau and the energy multiplication factor k for fusioning plasmas. McNally, J.R. Jr. (Oak Ridge National Lab., Tenn. (USA)). *Nucl. Fusion;* **17**: No. 6, 1273-1281(1977).

This paper presents some novel interpretations of fusion plasmas which may be of interest to both fission and fusion scientists and engineers. A new fusion ignition parameter (Tnsub(e)tausub(E))sub(I) is proposed which is proportional to $\beta^2 B^4$ and inversely proportional to the fusion power density (Psub(Fusion)) of a reacting plasma. Curves are given for many potential nuclear fusion fuels. The energy utilization factor in existing devices is defined as f=Psub(Fusion)/Psub(Loss)=(Tnsub(e)tausub(L))/(Tnsub(e)tausub(E))sub(I);in experimental plasmas, f has increased by about two orders of magnitude in the past decade and now exceeds 10^{-4} (a "nearest" fsup(*) exceeds 10^{-3}). The f factor is also analogous to its fission counterpart in the four-factor neutron multiplication factor k=f eta epsilon p, where f is the neutron thermal utilization factor. Past, present, and future fusion experiments are discussed briefly in this context.

27524 Formation of positive slope on electron runaway distribution in tokamaks. Papadopoulos, K.; Winsor, N. (Naval Research Lab., Washington, D.C. (USA)); Hui, B. (Science Applications, Inc., McLean, Va. (USA)). *Nucl. Fusion;* **17**: No. 5, 1087-1091(1977).

27525 Steady-state diffusion in a tokamak. Papaloizou, J.C.B.; Wesson, J.A. (UKAEA Research Group, Abingdon. Culham Lab.). *Nucl. Fusion;* **17**: No. 6, 1115-1122(1977).

Steady-state neoclassical diffusion calculations are described for conditions appropriate to tokamaks. Particle loss by diffusion is balanced by neutral recycling. It is found that with the boundary condition that the particles convect out their own energy, the electron temperature and current density are large at the boundary. The means by which the behaviour of the temperature at the boundary may be brought closer to that observed in experiments are discussed.

27526 Numerical simulation of Padua Eta-Beta reverse-field pinch. Park, W.; Chu, C.K. (Columbia Univ., New York (USA). Plasma Physics Research Lab.). *Nucl. Fusion;* **17**: No. 5, 1100-1102(1977).

27527 Plasma theory. Report on the third international (Kiev) conference held at Trieste, 5 - 9 April 1977. Sitenko, A. (AN Ukrainskoj SSR, Kiev. Inst. Teoreticheskoj Fiziki). *Nucl. Fusion;* **17**: No. 6, 1387-1390(1977).

This paper reports the main topics presented at the conference on "Plasma Theory" held at Trieste in April 1977.

27528 Magnetohydrodynamic equilibria of a non-circular cross-section stellarator. Talmadge, J.N.; Shohet, J.L. (Wisconsin Univ., Madison (USA)); Betancourt, O.L. (New York Univ., N.Y. (USA). Courant Inst. of Mathematical Sciences). *Nucl. Fusion;* **17**: No. 5, 1023-1030(1977).

Magnetohydrodynamic equilibria have been calculated numerically for a non-circular cross-section stellarator utilizing a three-dimensional, diffuse-plasma-profile, MHD code. Distinct minima of the poloidal field values were found in the vacuum which confirm the existence of stagnation points.

27529 Photon absorption and emission in Coulomb collisions in a magnetic field. Pavlov, G.G.; Panov, A.N. (AN SSSR, Moscow. Fiziko-Tekhnicheskij Inst.). *Zh. Eksp. Teor. Fiz.;* **71**: No. 2, 572-584(Aug 1976). (In Russian).

16 refs.; for English translation see the journal Sov. Phys. - JETP.

The photon absorption coefficients for various photon polarizations (dissipative part of the high frequency conductivity tensor) are found in case of the coulomb collisions in a magnetized nonrelativsistic nondegenerate plasma for arbitrary values of hνsub(B)/kT and hν/kT ν is the photon frequency, T the electron temperature and νsub(B) the electron cyclotron frequency). The absorption coefficients can be expressed in terms of the longitudinal and transverse effective collision frequencies ν long and ν tr which depend differently on the magnetic field. The frequency dependences of ν long and ν tr are considered and in particular the shape and height of the peaks (cyclotron resonances) for ν = sνsub(B) (s = 1.2...) which are most pronounced in a quantized magnetic field hνsub(B) $>>$ kT for ν tr. The dependences ν long, tr (ν) for hνsub(B)/kT = 3, 10 and 0.01 are found by numerical integration. The bremsstrahlung absorption coefficients in a quantized and classical (hνsub(B) $>>$ kT) fields are compared.

PLASMA PRODUCTION

27530 (EUR—5602, pp 311-316) **Crowbar experiments by ionizing shock waves and new methods.** Kasuya, K.; Kagaya, Y.; Murasaki, T. (Osaka Univ. (Japan)). 1976.

From 9. symposium on fusion technology; Garmisch-Partenkirchen, F.R. Germany (14 Jun 1976).

In Proceedings of the 9. Symposium on fusion technology.

Recent results on a crowbar method utilizing shock waves reflected by a pressure driven shock tube are presented. This crowbar technique could be used for plasma production.

27531 (UCRL—52363) **Target-plasma production by laser irradiation of a pellet in the Baseball II-T experiment.** Damm, C.C.; Foote, J.H.; Futch, A.H.; Goodman, R.K.; Hornady, R.S.; Osher, J.E.; Porter, G.D. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 14 Nov 1977. Contract W-7405-ENG-48. 19p. Dep. NTIS, PC A02/MF A01.

One way to generate a plasma target that can be used in conjunction with an injected neutral beam to initiate a high-energy plasma in a steady-state, magnetic-mirror field is by the laser irradiation of a solid pellet located within the confinement region. In the Lawrence Livermore Laboratory Baseball II-T experiment, a CO_2 laser was used to provide a two-sided irradiation of an ammonia pellet; the maximum laser intensity on the pellet was approximately 4 x 10^{12} W/cm^2. The 150-μm-dia pellets were guided to the laser focal spot in the Baseball II-T magnetic field using steering voltages controlled by a microcomputer-based system. Diagnostics showed complete ionization of the pellet, average ion energies in the keV range, synchronized triggering of the laser and the neutral beam, and rapid expansion of the plasma to a diameter that was a good match to the diameter of the neutral beam. Predictions obtained from the LASNEX code compared well with measured results. Although the laser-pellet approach was proven usable as a target-plasma startup system, it would be much more complicated and expensive than the method in which streaming plasma is used to trap the neutal beams.

27532 Fast expansions of laser-heated plasmas. Felber, F.S.; Decoste, R. (Naval Research Laboratory, Washington, D. C. 20375). *Phys. Fluids;* **21**: No. 3, 520-522(Mar 1978).

New analytic solutions describe ambipolar acceleration of fast ions from a steep, localized density gradient with a high electron temperature. A scaling law and estimates for the peak energy of ion species are presented.

27533 Intensity inversion in the Balmer spectrum of C^{5+}. Dixon, R.H.; Seely, J.F.; Elton, R.C. (Naval Research Laboratory, Washington, D. C. 20375). *Phys. Rev. Lett.;* **40**: No. 2, 122-125(9 Jan 1978).

Intensity inversion between the first (3 → 2) and second (4 → 2) Balmer series spectral lines of C^{5+} ions has been observed during plasma expansion into a buffer gas. Numerical modeling indicates that the Balmer spectrum is consistent with the Lyman spectrum and with charge-transfer pumping of the n = 4 level. Electron-ion recombination alone is insufficient to explain the observed intensity distribution.

27534 High-power electric-arc generators of low-temperature plasma. Koroteev, A.S.; Lomovtsev, M.A.; Boyarshinov, V.V. (Moscow). *High Temp. (USSR) (Engl. Transl.);* **15**: No. 2, 314-320(Sep 1977).

The basic principles of creating long-operating high-power plasmotrons are presented. Schematic diagrams of coaxial plasmotrons operating on a direct current are presented and the parameters of the plasmotrons and certain characteristics are given.

27535 Limits in the production of a low compressed high-beta plasma in the linear theta pinch Isar II. Koeppendoerfer, W.; Muenich, M.; Sommer, J. (Max-Planck-Institut fuer Plasmaphysik, Garching/Muenchen (Germany, F.R.)). pp 79-87 of Plasma physics and controlled nuclear fusion research 1976. Proceedings of the 6. international conference held by the IAEA at Berchtesgaden, 6-13 October 1976. Vol. 3. Vienna; IAEA (1977).

From 6. international conference on plasma physics and controlled nuclear fusion research; Berchtesgaden, F.R. Germany (6 Oct 1976).

See CONF-761012—.

The production of a shock-heated low compressed plasma was investigated in the linear experiment Isar II in preparation for a toroidal high-beta stellarator experiment. Compression ratios between 2.75 and 3 could be obtained at ion temperatures of 600 eV, electron temperatures of 70 eV, and electron densities of $2X10^{21}$ m^{-3} on axis. To achieve this, a special magnetic field pulse and a filling pressure of 4 mtorr was necessary. This filling density turned out to be the low limit at which ignition and preheating is still possible without contaminating the plasma too much and at which preheating and sufficient sweep-up of plasma in the main discharge is still possible. The neutron emission in series of discharges in deuterium and hydrogen, the measurement of hydrogen, deuterium and oxygen concentration and the investigation of quartz samples exposed to the discharges, revealed that the plasma interacts strongly with the vessel walls during its production. The walls were found to store $2X10^{20}$ particles per m^{-2} and about half the gas filling is exchanged by the wall surface in every discharge. The equilibrium radial density profile acquired a smooth Gaussian-like shape at 4 mtorr filling pressure. It starts to develop during the implosion phase and becomes strongly influenced by flute-type azimuthal modes of about 1.6 cm wavelength. The electron temperature stays at Tsub(e) approximately 70 eV smaller than the ion temperature. If circular cylindric symmetry is assumed, the current sheath and the electron energy equation yield an effective collision frequency of νsub(eff)=0.3ωsub(pi) well in agreement with other experiments. If, however, the current is assumed to flow on the flute distorted surface, a considerably smaller collision frequency can explain the observed electron temperature. The increased current drift velocity could in this case suffice to drive ion sound instabilities.

PLASMA INSTABILITIES

REFER ALSO TO CITATION(S) 27469

27536 (AD-A—043284) **Low frequency instability of liquid liner implosions driven by multiple free pistons. Memorandum report.** Cooper, A.L.; Turchi, P.J. (Naval Research Lab., Washington, D.C. (USA)). Jun 1977. 20p. (NRL-MR—3522). NTIS PC A02/MF A01.

The Rayleigh-Taylor instability is studied for an unstable interface composed of rigid finite elements. For wave lengths associated with the finite element scale size the classical Rayleigh-Taylor growth rates obtain. Wave lengths which are short compared with the element scale size are constrained by the rigid finite elements. The consequences of this behavior are discussed with respect to captive liner configurations for imploding liners. (Author)

27537 (CONF-771136—25) **Theoretical investigations relevant to magnetic fusion energy research. Progress report, January 1, 1977—January 1, 1978.** Kammash, T. (Michigan Univ., Ann Arbor (USA)). 1978. Contract EY-76-S-01-1478. 8p. Dep. NTIS, PC A02/MF A01.

From Annual American Physical Society meeting; Atlanta, GA, USA (7 Nov 1977).

Problems were examined and preliminary results are presented for the following: high frequency microinstabilities in field-reversed mirror geometry, particle orbits in field-reversed magnetic geometry, the variational approach to the drift instability, and viscous damping of ion cyclotron waves. (MHR)

27538 (COO—3497-24) **Annual progress report.** Simon, A.; Catto, P.J. (Rochester Univ., N.Y. (USA)). 5 Aug 1977. Contract EY-76-S-02-3497. 19p. Dep. NTIS, PC A02/MF A01.

Research has been performed on several topics on linear and nonlinear instabilities, primarily in geometries of interest to present and future magnetic fusion devices. The emphasis of the nonlinear studies has been on the dissipative trapped electron and drift cyclotron loss cone instabilities. The results of the former study are in good agreement with the experimental data in a linear mirror geometry. The latter studies are intended to provide predictions which can be checked by experiments on 2X PI B. The two mode bump-on-tail problem has also been solved. The thrust of the linear program has been toward understanding radial eigenvalue problems appropriate to trapped electron and collisionless drift instabilities in tokamaks. Investigations of tearing effects due to drift instabilities are also underway. In addition, the gyro-kinetic formulation has been generalized from the linearized to the full Vlasov operator.

27539 (EUR—5602) **Proceedings of the 9. symposium on fusion technology.** (Commission of the European Communities, Brussels (Belgium)). 1976. vp. (CONF-760631—). NTIS.

From 9. symposium on fusion technology; Garmisch-Partenkirchen, F.R. Germany (14 Jun 1976).

Abstracts for each of the included papers have been entered into the data base. (MOW)

27540 (EUR—5602, pp 411-422) **Plasma stabilization requirements of the reference theta-pinch reactor (RTPR).** Bartsch, R.R.; Krakowski, R.A.; Ribe, F.L. (Los Alamos Scientific Lab., N.Mex. (USA)). 1976.

From 9. symposium on fusion technology; Garmisch-Partenkirchen, F.R. Germany (14 Jun 1976).

In Proceedings of the 9. Symposium on fusion technology.

The reference theta-pinch reactor (RTPR) is considered as a high-beta stellarator, feed-back stabilized to the m=1 MHD mode and finite-Larmor-radius-stabilized to the m>=2 Vlasov-fluid modes. For an l=1, 0 equilibrium with l=2 feedback fields the ratio of peak feed-back power to thermonuclear power output for a linear-amplifier-driven system is found to be negligible. An impulse-control system involving capacitor drive further reduces the ratio by two orders of magnitude. Stabilization of the m>=2 modes is a critical consideration. It requires lowering the RTPR line density, subject to the constraint of acceptably low feed-back power. The required decrease in discharge filling pressure or minor radius must also be constrained by maintaining reactor energy balance. A parametric analysis indicates the relationship between plasma stabilization and reactor energy balance. There is a critical trade-off between the first-wall radius and the helical equilibrium field to maintain stabilization and energy balance.

27541 (IAE—2650) **Alfven wave instability stabilization in a two-component tokamak.** Mazur, V.A.; Mikhajlovskii, A.B. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow. Inst. Atomnoj Ehnergii). 1976. 26p. (In Russian). Dep. NTIS (US Sales Only), PC A03/MF A01.

Stabilization of the alfven waves instability in a two-component tokamak is theoretically investigated. The instability is supposed to be caused by fast ions produce in the tokamak when fast neutral atoms are injected into it. Collisional dissipation on trapped electrons is considered as a stabilizing factor. The investigation is carried out by the method of considering initial perturbations.

27542 (JEN—379) **Instabilities in fluid layers and in reaction-diffusion systems: Steady states, time-periodic solutions, non-periodic attractors, and related convective and otherwise non-linear phenomena.** Garcia Velarde, M. (Junta de Energia Nuclear, Madrid (Spain)). 1977. 165p. Dep. NTIS (US Sales Only), PC A08/MF A01.

Thermoconvective instabilities in horizontal fluid layers are discussed with emphasis on the Rayleigh-Benard model problem. Steady solutions and time-dependent phenomena (relaxation oscillations and transition to turbulence) are studied within the nonlinear Boussinesq-Oberbeck approximation. Homogeneous steady solutions, limit cycles, and inhomogeneous (ordered) spatial structures are also studied in simple reaction-diffusion systems. Lastly, the non-periodic attractor that appears at large Rayleigh numbers in the truncated Boussinesq-Oberbeck model of Lorenz, is constructed, and a discussion of turbulent behavior is given.

27543 **Observation of the dissipative trapped electron instability in toroidal geometry.** Prater, R.; Ejima, S.; Ohkawa, T.; Wong, S.K. (General Atomic Company, San Diego, California 92138). *Phys. Fluids;* **21**: No. 3, 434-442(Mar 1978).

Low frequency plasma density fluctuations have been observed in the common flux volume of the dc octopole. For collision frequencies comparable to the fluctuation frequency (which is close to the diamagnetic drift frequency), the fluctuations are identified as dissipative trapped electron modes. In the high collision frequency range the collisional drift wave is observed. A strong quenching of the trapped electron modes is observed when the local safety factor is a low-order rational number. Very little transport is associated with the observed fluctuations.

27544 **Radial normal mode calculation of warm plasma stabilization of the drift cone mode.** Gerver, M.J. (Laboratory of Plasma Studies, Cornell University, Ithaca, New York 14853). *Phys. Fluids;* **21**: No. 3, 443-446(Mar 1978).

The fraction Δ of warm plasma needed to stabilize the drift cone mode is calculated for a loss cone plasma slab in a uniform magnetic field with R/sub p/$\sim$a/sub H/$\sim k^{-1}$, where R/sub p/ is the width of the slab (representing the radial scale length), a/sub H/ is the hot ion Larmor radius, and k is the wavenumber of the mode. For 2XIIB-like parameters, a minimum Δ of 14% is needed for stability, which is consistent with experimental observations. This result is an improvement on previous calculations, which used the local approximation (assuming R/sub p/>>a/sub H/>>k^{-1}) and gave a minimum Δ of 10% for the same parameters. Information is also obtained on the radial location and width of the normal modes, and on the effect of varying the warm plasma radial density profile.

27545 **Parametric dependence of the ion cyclotron instability in a two-energy-component system.** Brecht, S.H.; Hitchcock, D.A.; Horton, W. Jr. (Fusion Research Center and Physics Department, University of Texas at Austin, Austin, Texas 78712). *Phys. Fluids;* **21**: No. 3, 447-460(Mar 1978).

The excitation of the ion cyclotron wave and the harmonic ion cyclotron waves by injection of a neutral beam is studied as a function of beam injection energy and angle. The fundamental mode is found to be stable for parameters similar to the current and future neutrally injected tokamaks. The harmonic cyclotron waves are found to have growth rates of a few percent of the ion cyclotron frequency when the thermal ion temperature is below a critical level. The results of these calculations are compared to several current experiments.

27546 **Comparative study of the axial and azimuthal bunching mechanisms in electromagnetic cyclotron instabilities.** Chu, K.R.; Hirshfield, J.L. (Science Applications, Inc., McLean, Virginia 22101). *Phys. Fluids;* **21**: No. 3, 461-466(Mar 1978).

A comparative study is presented of the axial and azimuthal bunching mechanisms of the electromagnetic electron cyclotron instability. Axial bunching can be described with a nonrelativistic treatment, but azimuthal bunching is relativistic in origin. As is well known, the axial bunching mechanism drives the Weibel-type instability while the azimuthal bunching mechanism drives the electron cyclotron maser instability. For an electron ensemble of cold helical trajectories, a unified physical interpretation of both instabilities is presented. It is shown that the two bunching mechanisms are actually simultaneously present in either instability and compete with one another. As a result, the dominant mechanism determines the type of instability. A criterion for distinguishing the two types of instabilities is derived. It is shown that the energy of the electrons plays an insignificant role in the criterion and, hence, should not be a factor in the justification of a nonrelativistic treatment. Regimes of validity of nonrelativistic models are defined, however. Applications to gyrotron experiments are discussed.

27547 **Influence of axial energy spread on the negative-mass instability in a relativistic nonneutral E layer.** Uhm, H.; Davidson, R.C. (Department of Physics and Astronomy, University of Maryland, College Park, Maryland 20742). *Phys. Fluids;* **21**: No. 2, 265-271(Feb 1978).

The influence of an axial energy spread on the negative-mass instability in a relativistic nonneutral E layer aligned parallel to a uniform axial magnetic field B$_0$e/sub z/ is investigated. The stability analysis is carried out within the framework of the linearized Vlasov—Maxwell equations. It is assumed that the E layer is thin with radial thickness (2a) much smaller than the mean radius (R$_0$), and that ν/γ_0very-much-less-than1, where ν is Budker's parameter and $\gamma_0 mc^2$ is the mean electron energy. Stability properties are investigated for the choice of electron distribution function in which all electrons have the same value of canonical angular momentum (P/sub theta P0/=const) and a step-function distribution in axial momentum p/sub z/. The negative-mass growth rate is calculated including the important stabilizing influence of axial energy spread (ΔE), and it is shown that a modest energy spread ($\Delta E/\gamma_0 mc^2 \cong$ a few percent) is sufficient to stabilize perturbations with axial wavenumber satisfying $k^2R^2_0 > \text{or} \simeq 1$.

27548 **Nonlinear dynamics of drift-cyclotron instability.** Aamodt, R.E.; Lee, Y.C.; Liu, C.S.; Rosenbluth, M.N. (Science Application, Inc., Boulder, Colorado 80302). *Phys. Rev. Lett.;* **39**: No. 26, 1660-1663(26 Dec 1977).

Nonlinear shift of the ion gyrofrequency by the electrostatic ion cyclotron wave is shown to detune the resonance between the ion cyclotron wave and the ion drift wave, thereby stabilizing the drift-cyclotron instability. Solution to the resulting wave equation exhibits nonlinear oscillations.

27549 **Kinetic and numerical studies of microstability properties and anomalous transport in theta pinches.** Davidson, R.C.; Gladd, N.T.; Huba, J.; Hui, B.H.; Liewer, P.C.; Liu, C.S.; Mondt, J.P.; Ogden, J.M.; Wu, C.S. (Maryland Univ., College Park (USA)); Hamasaki, S. pp 113-120 of Plasma physics and controlled nuclear fusion research 1976. Proceedings of the 6. international conference held by the IAEA at Berchtesgaden, 6-13 October 1976. Vol. 3. Vienna; IAEA (1977).

From 6. international conference on plasma physics and controlled nuclear fusion research; Berchtesgaden, F.R. Germany (6 Oct 1976).

See CONF-761012—.

This paper summarizes several recent analytic and numerical studies of microstability properties, anomalous transport, and implosion and post-implosion dynamics in theta-pinch plasmas.

27550 Thermal thermonuclear instability in a tokamak reactor. Kolesnichenko, Ya.I.; Reznik, S.N. (AN Ukrainskoj SSR, Kiev. Inst. Yadernykh Issledovanij). pp 347-357 of Plasma physics and controlled nuclear fusion research 1976. Proceedings of the 6. international conference held by the IAEA at Berchtesgaden, 6-13 October 1976. Vol. 3. Vienna; IAEA (1977).

From 6. international conference on plasma physics and controlled nuclear fusion research; Berchtesgaden, F.R. Germany (6 Oct 1976).

See CONF-761012—.

Thermal thermonuclear instability (thermonuclear burning instability) in a tokamak reactor is considered on the assumption that the duration of the plasma pulse is considerably longer than the plasma energy life-time. It was shown previously that this instability gives rise to self-heating of the plasma as a result of which the plasma temperature tends towards the steady-state value Tsup(st) at which $da/dT>0$ where a(T) is a function defined by the steady-state equation for the plasma energy balance. In the present paper, the effect of the finiteness of the time taken for thermalization of the highly energetic α-particles (thermonuclear reaction products) and also the finiteness of the time taken for exchange of energy between the electron and ion components of the plasma on the thermal instability is investigated. It is shown that when allowance is made for these factors, the steady states with positive derivatives of da/dT are stable as before. The approximation to these states may however assume the form of damped temperature oscillations about Tsup(st). In the case of a non-isothermal plasma, both the function a(Tsub(i)) and a(Tsub(e)), where Tsub(e) and Tsub(i) are respectively the plasma electron and ion temperatures, may be used to describe the steady states. The possibility of non-self-sustaining stable thermonuclear burning is also considered in this paper. It is shown that, unlike self-sustaining thermonuclear burning, when additional power is supplied to the plasma, it is possible for a stable steady-state (quasi-steady-state) thermonuclear reaction regime to be established at relatively low plasma temperatures (T approximately 10 keV). In this case, the energy released as a result of fusion reactions may considerably exceed the energy supplied to the plasma.

27551 Energy principles for non-ideal MHD. Tasso, H. (Max-Planck-Institut fuer Plasmaphysik, Garching/Muenchen (Germany, F.R.)). pp 371-381 of Plasma physics and controlled nuclear fusion research 1976. Proceedings of the 6. international conference held by the IAEA at Berchtesgaden, 6-13 October 1976. Vol. 3. Vienna; IAEA (1977).

From 6. international conference on plasma physics and controlled nuclear fusion research; Berchtesgaden, F.R. Germany (6 Oct 1976).

See CONF-761012—.

Energy principles were found for the three-dimensional plasmas of arbitrary geometry with viscosity and finite Larmor radius (FLR) effects and for two-dimensional plasmas of arbitrary shape, taking into account viscosity, FLR effects and resistivity. This allows a scaling-free decision about stability in the same way as for ideal MHD (necessary and sufficient criterion). Rough estimates of growth rates can also be made. Application to tokamaks yields the results: (1) Very plausible explanation of the anomalous skin effect at the beginning of the discharge; (2) Reduction by a factor of 100 of the resistive kink or ideal internal kink growth rate of the $m=1$, $n=1$ mode by inclusion of the viscosity parallel to the magnetic field, which explains the observations; (3) Formulation of a condition allowing the use of test functions to study the stability of configurations with stagnation points and magnetic islands. Application to the high-β,$l=1$ stellarator allows the explanation of the stabilization of $m=2$ by FLR in the present experiments, but parallel viscosity could strongly destabilize plasmas of higher temperatures unless their ideal MHD stability is improved. Finally, an energy principle for all three-dimensional resistive perturbations in the tokamak scaling is given even with FLR and viscosity. Helical perturbations can always be unstable.

27552 Structure of low-frequency oscillations during the disruptive instability in the TFR tokamak. *Nucl. Fusion;* **17**: No. 6, 1283-1296(1977).

The behaviour of the $m=0$, $n=0$; $m=1$, $n=1$ and $m=2$, $n=1$ low-frequency oscillations has been studied within the framework of the current disruption in TFR. The experimental observations show the fundamental role of the $m=2$ mode in triggering and growth of the instability, the existence of two $m=1$ modes near the $q=1$ surface, one of which is directly connected with the $m=2$ mode.

27553 Moment equations treatment of the reconnecting mode. Basu, B.; Coppi, B. (Massachusetts Inst. of Tech., Cambridge (USA)). *Nucl. Fusion;* **17**: No. 6, 1245-1255(1977).

A mode with azimuthal wave number $m=1$ can be excited in a resistive plasma column as a result of reconnection of the magnetic field lines under conditions for which the ordinarily known internal kink mode given by the ideal MHD theory would be stable. In the absence of resistivity, magnetic reconnection would not be allowed and the relevant mode would be singular at a specified radius within the plasma column as in the case of the resistive tearing modes that are found for $m>=2$. The analysis presented here is based on a set of moment equations that are appropriate for relatively high-temperature and low-collisionality regimes. In these regimes, the mode growth rate tends to weaken considerably as the temperature increases and the mode acquires a frequency of oscillation with phase velocity close to the electron diamagnetic velocity, as a result of the effects of finite ion gyroradius and finite drift wave frequency, even in the absence of an equilibrium radial electric field.

27554 Anomalous interaction of alpha particles with the dissipative trapped-ion mode. Bhadra, D.K. (General Atomic Co., San Diego, Calif. (USA)). *Nucl. Fusion;* **17**: No. 5, 1085-1087(1977).

27555 Theory of the ubiquitous mode. Coppi, B. (Massachusetts Inst. of Tech., Cambridge (USA)); Pegoraro, F. (Scuola Normale Superiore, Pisa (Italy)). *Nucl. Fusion;* **17**: No. 5, 969-993(1977).

Standing modes along the magnetic field lines and with frequencies between the mean ion transit and electron bounce frequencies are driven unstable by a combination of effects including inverse Landau damping, collisional de-trapping of electrons and magnetic curvature drifts in a magnetically confined plasma. The mode phase velocity, depending on the plasma parameters and on the mode perpendicular wavelength, is either in the direction of the electron diamagnetic velocity (electron drift mode) or in the direction of the ion diamagnetic velocity (ubiquitous mode). An intermediate region exists where the mode becomes fluid-like and is driven by the magnetic curvature drift. This fluid-like instability is shown to appear for wavelengths longer than the ion gyroradius and is expected to affect significantly the rate of particle and thermal energy transport in high-temperature toroidal-confinement devices.

27556 Anomalous transport in high-temperature plasmas with applications to solenoidal fusion systems. Davidson, R.C. (Maryland Univ., College Park (USA). Dept. of Physics and Astronomy); Krall, N.A. (Science Applications, Inc., La Jolla, Calif. (USA)). *Nucl. Fusion;* **17**: No. 6, 1313-1372(1977).

The linear, non-linear, and anomalous transport properties associated with various micro-instabilities driven by cross-field currents in high-temperature plasmas are reviewed. Particular emphasis is placed on instabilities pertinent to the implosion and post-implosion phases of theta-pinch plasmas, e.g. Buneman (electron-ion two-stream), ion acoustic, lower-hybrid-drift, electromagnetic ion cyclotron, and ion-ion cross-field instabilities. Analytic studies of the nonlinear and quasi-linear evolution of these instabilities are presented, together with a detailed comparison with computer simulation experiments to test the validity of the various theoretical models and non-linear saturation mechanisms. A general theoretical formalism is presented which describes, in a self-consistent manner, the macroscopic transport produced by the (short-wave-length) turbulence associated with the microinstabilities enumerated above. The experimental evidence that such a self-consistent anomalous transport model is required for describing the implosion behaviour (characterized by diffuse current sheaths) in rapidly pulsed theta pinches is reviewed, together with the early attempts at modelling these implosions numerically with a one-fluid (MHD) model including artificial viscosity. It is shown that fluid-numerical simulations that include (at each space and time step) the effects of anomalous transport in a fully self-consistent manner, explain several features of the experimental observations

27557 Local, ideal and resistive stability in tokamaks with non-circular cross-section. Green, B.J.; Zehrfeld, H.P. (Max-Planck-Institut fuer Plasmaphysik, Garching/Muenchen (Germany, F.R.)). *Nucl. Fusion;* **17**: No. 6, 1133-1142(1977).

Recently, the conditions for stability of an arbitrarily shaped, finite-pressure toroidal plasma against localized ideal and resistive modes were presented. The characteristic time scale for local instability with respect to ideal modes is small compared with that for resistive modes so that an investigation of ideal local stability is a prerequisite for an assessment of non-ideal local stability. Here we consider the stability of a particular class of non-circular cross-section tokamak equilibria with respect to such modes. The equilibria are described analytically so that no ordering or expansion procedure is necessary, and both ideal and resistive stability are investigated over the whole plasma region. The effects of plasma shape (vertical elongation and triangularity), as well as aspect ratio are investigated and particular reference is made to next-generation tokamak designs (e.g. JET).

27558 Ballooning instabilities in toroidally linked mirror systems. Hastie, R.J.; Watson, C.J.H. (UKAEA Research Group, Abingdon. Culham Lab.). *Nucl. Fusion;* **17**: No. 6, 1153-1164(1977).

This paper examines the stability against ballooning modes of plasma equilibria in toroidally linked mirror configurations consisting of a number of quadrupole minimum-B mirrors linked toroidally. On the basis of the Kruskal-Oberman energy principle, a class of displacements is identified which are potentially unstable, and a

necessary criterion for stability is derived. The criterion is obtained from the eigenvalues of an ordinary differential equation, which determines the variation of the displacement along a field line. The coefficients in the equation are determined by the configuration, and by inserting various model configurations, estimates are obtained of the maximum value of β consistent with stability. In cases of interest, quite high β-values are obtained.

27559 Magnetohydrodynamic instabilities in a current-carrying stellarator. Matsuoka, K.; Miyamoto, K.; Ohasa, K.; Wakatani, M. (Nagoya Univ. (Japan). Inst. of Plasma Physics). *Nucl. Fusion;* **17**: No. 6, 1123-1131(1977).

Numerical studies on the stability of kink and resistive tearing modes in a current-carrying linear stellarator are presented for various current profiles and helical fields. In the case of an l=2 helical field, the magnetic shear vanishes and the stability diagram is given by the straight lines with iotasup(sigma)+iotasup(delta)=const., where iotasup(sigma) is the rotational transform due to the plasma current and iotasup(delta) is that due to the helical field. For the l=2 stellarator with iotasup(delta)=iotasup(delta)/2π>0.5, the magnetohydrodynamic stability against kink and tearing modes is improved compared to that in tokamaks. When an l=3 helical component exists, magnetic shear plays an important role in the stability properties. The stability diagrams become fairly complex; they are, however, understandable from properties of the Euler equation. It should be noted that the internal kink modes are made more unstable than in a tokamak, because of the l=3 helical field.

27560 Linear and non-linear calculation of the tearing mode in reversed field pinches. Dibiase, J.A.; Killeen, J.; Robinson, D.C.; Schnack, D. (California Univ., Livermore (USA). Lawrence Livermore Lab.). pp 283-289 of Pulsed high beta plasmas. Proceedings of the third topical conference held at UKAEA Culham Laboratory, Abingdon, Oxfordshire, UK 9-12 September 1975. Evans, D.E. (ed.). Oxford; Pergamon Press (1976).

From 3. topical conference on pulsed high beta plasmas; Abingdon, Oxfordshire, UK (9 Sep 1975).

See CONF-750944—.

A hydromagnetic model has been developed to study resistive instabilities in cylindrical geometry, and the model is applied to study specific diffuse-pinch configurations. The MHD equations include the effects of compressibility, finite resistivity, viscosity, and thermal conductivity. The plasma equilibrium configuration is assumed known and is specified by Bsub(theta0)(r), Bsub(z0)(r), eta$_0$(r), rho$_0$(r), T$_0$(r) and these functions can be chosen to describe a particular experiment. Perturbations of the form f$_1$(r,t) exp i(mtheta + ksub(z)z are used for all plasma and field variables, and the resulting linear partial differential equations are solved numerically as an initial value problem using an implicit difference scheme.

PLASMA WAVE PHENOMENA

27561 (EUR-CEA-FC—895) **Note on the characters of the dispersion equation of fast magnetosonic wave near the second ion-cyclotron harmonic.** (Association Euratom-CEA sur la Fusion, Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France). Dept. de Physique du Plasma et de la Fusion Controlee). May 1977. 19p. Dep. NTIS (US Sales Only), PC A02/MF A01.

The dispersion relation of a warm plasma immersed in a static magnetic field was examined in the frequency range near the ion cyclotron harmonic. The appearance of a region for the wave conversion from the fast magnetosonic mode to the ion Bernstein one is discussed. The conditions for the appearance are expressed by simple formulae and easily juged graphically. The results obtained are well consistent with those from previous works. It should be concluded that with the parameters of the experiments of TFR it might not have a large possibility for explaining the enhanced wave absorption by the mechanism of the wave conversion near the resonance layer.

27562 (IAE—2552) **Alfven short-wave excitation by high-energy ions in a tokamak.** Bizli, K.O.; Lominadze, D.G.; Mikhajlovskij, A.B. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow. Inst. Atomnoj Ehnergii). 1975. 5p. (In Russian). Dep. NTIS (US Sales Only), PC A02/MF A01.

Excitation of short-wave alfven oscillations by high-energy ions in a tokamak has been theoretically investigated. It is shown that sigma-function ion distribution stable to long-wave perturbations may become unstable, provided the transverse perturbation length is comparable with the orbit dimension of ion drift motion.

27563 (IAE—2651) **To the nonlinear theory of alfven wave excitation in a tokamak.** Mikhajlovskii, A.B.; Pyatak, A.I.; Fridman, A.M. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow. Inst. Atomnoj Ehnergii). 1976. 17p. (In Russian). Dep. NTIS (US Sales Only), PC A02/MF A01.

Excitation of a monochromatic alfven wave by a beam of fast ions in a tokamak has been theoretically investigated. It is shown that the problem may be mathematically reduced to the O'Neil problem on a langmuir wave.

27564 (IAE—2655) **Quasy - linear theory of satellite interaction of alphaparticles with Alfven waves in a tokamak.** Mikhajlovskii, A.B.; Pyatak, A.N.; Fridman, A.M. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow. Inst. Atomnoj Ehnergii). 1976. 14p. (In Russian). Dep. NTIS (US Sales Only), PC A02/MF A01.

Short-wave instabilities on trapped electrons in a tokamak are theoretically investigated under a high plasma pressure. The instabilities are shown to become essentially nonpotential at βsub(y)(>=1), where βsub(y) is the ratio of the plasma pressure to the magnetic field pressure. They are suppressed at βsub(y)> or approximately 1\Vepsilon, where epsilon is the small to large tokamak ratio.

27565 (IPPJ—253) **Contribution of the second order terms to the nonlinear shallow water waves.** Ichikawa, Y.H.; Aoyama, T. (Nagoya Univ. (Japan). Inst. of Plasma Physics). Jun 1976. 29p. Dep. NTIS (US Sales Only), PC A03/MF A01.

Contribution of the second order terms in the reductive perturbation theory has been investigated for the nonlinear shallow water waves. The fundamental equations are reduced to a coupled set of the Korteweg-de Vries equation for the first order horizontal velocity and a linear inhomogeneous equation for the second order arbitrary function. Structure of the coupled set of equations turns out to be the same as in the case of nonlinear ion acoustic wave. A steady state solution of the coupled set of equations has been examined in comparison with Laiton's analysis of the second order contribution of the Friedrich's expansion for the nonlinear shallow water waves.

27566 (JAERI-M—6902) **Numerical studies of lower hybrid wave propagation in JFT-2.** Imai, T.; Nagashima, T.; Azumi, M. (Japan Atomic Energy Research Inst., Tokyo). Feb 1977. 47p. (In Japanese). Dep. NTIS (US Sales Only), PC A03/MF A01.

Parametric dependence of the position of the turning point of lower hybrid wave is studied in an electrostatic fluid approximation. The radial position of the turning point is affected by the impurity concentrations and the refractive index parallel to the external magnetic field. The possibility of electron heating due to electron Landau damping is also described. A multi-waveguide array antenna available in JFT-2 is discussed.

27567 Statistical formulation of one-dimensional electron fluid turbulence. Fyfe, D.; Montgomery, D. (Department of Physics and Astronomy, The University of Iowa, Iowa City, Iowa 52242). *Phys. Fluids;* **21**: No. 3, 316-326(Mar 1978).

A one-dimensional electron fluid model is investigated using the mathematical methods of modern fluid turbulence theory. Non-dissipative equilibrium canonical distributions are determined in a phase space whose coordinates are the real and imaginary parts of the Fourier coefficients for the field variables. Spectral densities are calculated, yielding a wavenumber electric field energy spectrum proportional to k^{-2} for large wavenumbers. The equations of motion are numerically integrated and the resulting spectra are found to compare well with the theoretical predictions.

27568 Observations of stimulated Brillouin backscattering from a magnetically confined plasma. Massey, R.S.; Pietrzyk, Z.A.; Scudder, D.W. (Aerospace and Energetics Research Program, University of Washington, Seattle, Washington 98195). *Phys. Fluids;* **21**: No. 3, 396-403(Mar 1978).

Backscattered laser radiation has been observed from a CO_2 laser-produced and heated underdense plasma in a steady solenoid magnetic field, and is attributed to the stimulated Brillouin scattering process. Spectral measurements and observations of the dependence of the backscattered intensity on laser power are presented to support this identification. Backscattered radiation, amounting to as much as 1% of the incident power, was found to be redshifted by 80—100 A, the shift expected for stimulated Brillouin scattering from a plasma at the measured temperature T/sub e/=80 +- 25 eV. Data are also presented on the dependence of backscattered power on the density and convergence angle of incoming radiation.

27569 Effects of beat-wave electron trapping on stimulated Raman and Thomson scattering. Cohen, B.I.; Kaufman, A.N. (Physics Department and Lawrence Berkeley Laboratory, University of California, Berkeley, California 94720). *Phys. Fluids;* **21**: No. 3, 404-412(Mar 1978).

The influence of electron trapping on a large amplitude plasma oscillation driven by the nonlinear interaction of two electromagnetic waves (stimulated Raman scattering) is studied analytically and by means of numerical simulation. When the plasma oscillation is resonantly excited to sufficiently large amplitude and electron trapping occurs, there ensues considerable modification of the electron velocity distribution function. The stimulated scattering ceases to be a resonant three-wave process but continues as induced scattering by resonant electrons (stimulated Thomson scattering). The

scattering of the electromagnetic waves becomes slower, but does not terminate with the onset of particle trapping in the beat wave.

27570 Quasi-neutral particle simulation model with application to ion wave propagation. Okuda, H.; Dawson, J.M.; Lin, A.T.; Lin, C.C. (Plasma Physics Laboratory, Princeton University, Princeton, New Jersey 08540). *Phys. Fluids;* **21**: No. 3, 476-482(Mar 1978).

A new class of particle simulation models has been developed which eliminates the high-frequency space charge oscillations while keeping the low-frequency ion-density fluctuations unmodified. Physically, the quasi-neutrality is maintained as the adiabatic electrons follow the ion-density fluctuations so as to establish the Debye shielding. It is, therefore, possible to use an integration time step comparable to the characteristic time scale of the low-frequency oscillations so that realistic plasma parameters can be used in the present simulation model. Applications to ion sound wave propagation, ion-ion two-stream instability, and the low-frequency fluctuation spectrum in a magnetic field are given. The way in which to include the nonadiabatic electrons in the model is also discussed.

27571 Electron Landau damping and electron collisions. Sperling, J.L. (General Atomic Company, San Diego, California 92138). *Phys. Fluids;* **21**: No. 3, 514-516(Mar 1978).

The effect of electron-electron collisions on the Landau damping of a single wave in a magnetized or unmagnetized plasma is calculated using a model Fokker—Planck operator. The resulting form of Landau damping could play a role in the saturation of some parametric and trapped-particle instabilities.

27572 Phase mixing in the continuous spectrum of Alfven waves. Pritchett, P.L.; Dawson, J.M. (Department of Physics, University of California, Los Angeles, California 90024). *Phys. Fluids;* **21**: No. 3, 516-518(Mar 1978).

The predicted damping of Alfven waves in a nonuniform plasma is observed in a magnetohydrodynamic computer calculation. The results are interpreted in terms of a simple model of independent oscillators.

27573 Observation of electron-ion instability in counterstreaming ion beams and plasma system. Nakamura, Y.; Nomura, Y.; Itoh, T. (Institute of Space and Aeronautical Science, University of Tokyo, Komaba, Meguro-ku, Tokyo, Japan). *Phys. Rev. Lett.;* **39**: No. 25, 1622-1625(19 Dec 1977).

Instabilities in a triple-plasma device which produces counterstreaming ion beams are investigated. We observed a new type of standing oscillation whose wavelength is given by D/n, where D is the distance between boundaries and n is an integer. The phase velocity and the critical beam velocity are compared with theory.

27574 Diverging solitons and their transition to dispersive waves. Chen, T.; Schott, L. (Saskatchewan Univ., Saskatoon (Canada). Dept. of Physics). *Plasma Phys.;* **19**: No. 10, 959-967(Oct 1977).

The properties of the cylindrical ion acoustic solitons which diverge from the exciter are compared with those of plane solitons. The geometrical expansion of the wave fronts leads to a transition of the solitons to a dispersive oscillatory wave train even if the initial perturbation is a one-dimensional soliton. In this transitional regime good agreement is observed between the experiment and numerical solutions of the cylindrical Korteweg-de Vries equation.

27575 Non-linear Langmuir wave modulation in collisionless plasma. Dysthe, K.B. (Tromsoe Univ. (Norway)); Pecseli, H.L. (Research Establishment Risoe, Roskilde (Denmark)). *Plasma Phys.;* **19**: No. 10, 931-943(Oct 1977).

A non-linear Scroedinger equation for Langmuir waves is presented. The equation is derived by using a fluid model for the electrons, while both a fluid and a Vlasov formulation are considered for the ion dynamics. It is found that the two formulations lead to significant differences in the final results, especially in the expressions concerning the modulational instability of a plane Langmuir wave. It is thus demonstrated that when the Vlasov equation for the ions is applied, a Langmuir wave is modulationally unstable for arbitrary perturbations independent of the unperturbed wave amplitude, in contrasts to what is found for fluid ions. A simple analogy with negative energy waves explaining the different features of the two cases is outlined.

27576 Effects of an ion beam on the motion of solitons in an ion beam-plasma system. Gell, Y.; Roth, I. (Tel Aviv Univ. (Israel). Dept. of Physics and Astronomy). *Plasma Phys.;* **19**: No. 10, 915-924(Oct 1977).

The effects of a finite temperature ion beam traversing a plasma on the motion and characteristics of ion acoustic solitons were investigated. The soliton's width and amplitude as deduced from a Korteweg-de Vries equation were considered for the case when both ions species (beam and plasma) were adiabatic and for the case where one of the species was isothermal. For the latter case no significant beam effect was found. In the former case, considering the beam ion heavier than the plasma ions, the existence of a critical velocity of the beam Vsub(c) was found such that an increase in the beam velocity up to Vsub(c) resulted in an increase of the amplitude and a very slight increase in the width of the soliton; increasing the velocity beyond Vsub(c) resulted in a decrease of both the amplitude and the width. Vsub(c) was found to be a decreasing function of the mass ratio of the plasma and beam ions. The effects of changes in the temperature of the ion components on the characteristics of the solitons was also studied.

27577 Induced radiation from a plasma cylinder. Gradov, O.M.; Tegeback, R. (P.N. Lebedev Institute, USSR Academy of Sciences, Moscow (USSR)). *Plasma Phys.;* **19**: No. 10, 979-987(Oct 1977).

The spectra of the so called leaking modes of a cold plasma cylinder are studied. The parametric influence of an external electromagnetic wave with the electric field changed along the cylinder radius is considered. Linear theory allows us to determine the characteristic growth time of the radiation intensity from the plasma at a frequency equal to half the frequency of the external wave and also the threshold value above which such a growth takes place. The stationary value of the radiation intensity and the time to establish this state are determined on the basis of a study of the non-linear interaction between the eigen oscillations. The investigated saturation mechanism for the instability consists of energy transfer from growing modes to leaking waves, which do not interact with the external field, and dissipation due to radiation into vacuum.

27578 Computer study of many waves in the small cold beam and plasma interaction. Winfrey, J.H.; Dunlop, M.L. (California Polytechnic State University, San Luis Obispo, California (USA)). *Plasma Phys.;* **19**: No. 10, 901-914(Oct 1977).

When a small and fast, monoenergetic electron beam enters a relatively cold plasma, the combined system is unstable to the growth of waves. Although the Single Wave Model has been successful in predicting initial linear growths, the nonlinear saturation level and the early stages of amplitude bouncing, it does not predict correctly the subsequent nonlinear wave behaviour observed in experiments. A very broad spectrum of waves is measured at this point, suggesting that many waves determine the later stages of nonlinear development. Fifteen waves are modeled and their linear and nonlinear self-consistent evolution with the beam and a nonresonant plasma are followed. Since nonlinear theory shows that temporally and spatially growing waves satisfy different dispersion relations, the problem for both kinds of boundary conditions is solved.

27579 Self-motion and collective behaviour of classical one-component plasmas. Sjoedin, S.; Mitra, S.K. (Chalmers Tekniska Hoegskola, Goeteborg (Sweden). Institutionen foer Teoretisk Fysik). *J. Plasma Phys.;* **10**: No. 9, L163-L167(Sep 1977).

The self- and collective motions of one-component plasmas are investigated with the aid of a kinetic theory of classical fluids developed recently by Sjoegren and Sjoelander (Ann. Phys.; N.Y. in press). Present calculations show a strong coupling between self- and collective motions and a change in the behaviour of the plasma dispersion relation with increasing density, in agreement with computer simulations.

27580 Two-dimensional self-modulation of a whistler wave propagating along the magnetic field in a plasma. Karpman, V.I.; Washimi, H. (AN SSSR, Moscow. Inst. Zemnogo Magnetizma, Ionosfery i Rasprostraneniya Radiovoln). *J. Plasma Phys.;* **18**: 173-187(Aug 1977).

Two-dimensional nonlinear self-modulations of a high-frequency whistler wave propagating along an applied magnetic field in a plasma are investigated. New, fairly broad, regions of modulational instabilities in directions oblique to the initial wave propagation are derived with growth rates much greater than in the case of 'parallel' self-modulation. The largest growth rate appears to be for the angles corresponding to the parametric instabilities. Nonlinear solutions describing the envelope solitons propagating obliquely to the initial wave are also discussed. The results are in qualitative agreement with recent experiments.

27581 Kinetic theory of a resonance radiation of a magnetic plasma from an open periodic waveguide. Gestryina, G.M.; Kobeliev, B.M.; Shestopalov, V.P. (AN Ukrainskoj SSR, Kharkov. Inst. Radiofiziki i Ehlektroniki). *Dopov. Akad. Nauk Ukr. RSR, Ser. A;* No. 1, 53-57(Jan 1977). (In Russian).

In the framework of the linear theory based on a description of plasma by the one-dimensional kinetic equation it is shown that on excitation by a modulated electron flux of a narrow-gap periodic wave guide, filled with magnetized plasma, with some restrictions imposed upon parameters, there may arise anomalously strong leakage of the diffraction field. In this case the radiated energy flux is in inverse proportion to the square of the radiation angle sine and is invariant relative to the thermal spread of plasma electrons. A possibility is indicated of using the effect for plasma diagnostics.

27582 Plasma-wave coupling and propagation using phased waveguide arrays. Bernabei, S.; Hooke, W.M.; Motley, R.W.; Paoloni,

F.J. (Princeton Univ., N.J. (USA). Plasma Physics Lab.); Heald, M.A. (Swarthmore Coll., Pa. (USA). Dept. of Physics); Brambilla, M. (Association, EURATOM-CEA, Centre d'Etudes Nucleaires, Grenoble, France); Getty, W.D. (Michigan Univ., Ann Arbor (USA). Electron Physics Lab.). *Nucl. Fusion;* **17**: No. 5, 929-943(1977).

A study of the coupling and propagation of electron plasma waves excited by waveguide arrays is presented. The waves are generated in a low-temperature, linear plasma column in a homogeneous magnetic field. As predicted from a theoretical model, under appropriate conditions efficient coupling to plasma waves can be obtained. These studies are of relevance to plasma heating in that the modes are identical with those that must be generated in any lower hybrid heating experiment. We discuss the implications of these results with respect to future heating experiments on large devices.

27583 Observation of propagating m=1 waves in Scyllac. Cantrell, E.L.; Miller, G.; Quinn, W.E.; Riesenfeld, W. (Los Alamos Scientific Lab., N.Mex. (USA)). *Nucl. Fusion;* **17**: No. 5, 1091-1094(1977).

27584 Heating tokamaks via the ion-cyclotron and ion-ion hybrid resonances. Perkins, F.W. (National Center for Atmospheric Research, Boulder, Colo. (USA)). *Nucl. Fusion;* **17**: No. 6, 1197-1224(1977).

The ion-ion hybrid resonance can occur at high plasma densities in tokamaks and thereby absorb energy from the fast magnetosonic mode which would otherwise propagate freely. Ion-cyclotron resonance regions, although they occur in the low-density peripheral plasma, can nonetheless cause sufficient absorption to compete with fundamental cyclotron resonance damping by ions. For the ion-ion hybrid resonance it is shown that: (1) the energy absorption occurs via a sequence of mode conversions. (2) A poloidal field component normal to the ion-ion hybrid mode conversion surface strongly influences the mode conversion process, so that roughly equal electron and ion heating occurs in the present proton-deuterium experiments, while solely electron heating is predicted to prevail in deuterium-tritium reactors. (3) The ion-ion hybrid resonance suppresses toroidal eigenmodes. (4) Wave absorption in minority fundamental ion-cyclotron heating experiments will be dominated by ion-ion hybrid mode conversion absorption for minority concentrations exceeding roughly 1%.

27585 Nonlinear stage of parametric interaction of waves in an active medium. Al'terkop, B.A.; Volokitin, A.S.; Tarakanov, V.P. (AN SSSR, Moscow. Inst. Vysokikh Temperatur). *Zh. Eksp. Teor. Fiz.;* **71**: No. 2, p. 547-556(Aug 1976). (In Russian).

The conditions for saturation of an unstable mode due to its parametric decay into undamped perturbations are investigated. It is demonstrated that the instability cannot be stabilized if the instability increment exceeds the maximal damping. The dynamics of the multimode regime which thus arises is considered for the case of strong Langmuir turbulency. The maximal field amplitude is determined for this particular case.

27586 Investigation of the transparency of the wave barrier for electron plasma waves in a magnetoactive plasma. Lisitchenko, V.V.; Romanyuk, L.I.; Ustalov, V.V. (AN Ukrainskoj SSR, Kiev. Inst. Yadernykh Issledovanij). *Zh. Eksp. Teor. Fiz.;* **71**: No. 2, p. 537-546(Aug 1976). (In Russian).

Theoretical estimates are presented for the transparency coefficient of the wave barrier for electron plasma waves in a magnetized plasma. Experimental dependences of spatial damping of the wave and of the transparency coefficient of the barrier on the density of the surrounding plasma and frequency of excited oscillations are obtained for various barrier widths. The experimental dependences are compared with theoretical ones. Satisfactory agreement is demonstrated.

27587 Phase stochastization mechanism and wave turbulence structure in dissipative media. Vyshkind, S.Ya.; Rabinovich, M.I. (Gor'kovskij Gosudarstvennyj Univ. (USSR). Nauchno-Issledovatel'skij Radiofizicheskij Inst.). *Zh. Eksp. Teor. Fiz.;* **71**: No. 2, p. 557-571(Aug 1976). (In Russian).

Turbulence mode models in dissipative media with hydrodynamic type of nonlinearity are considered. It is assumed that only one mode possesses an increment, viz. the decay mode. By qualitative methods and a computer experiment it is shown that stochasticity is already possible in two- and three-mode models. In cases when the decay conditions are ambiguous, the competition between various pairs arising on decay of an unstable mode is investigated. Turbulence with a broad instability range is described within the framework of the kinetic equation for complex quasiparticles, the stochastic triplets.

27588 Plasma turbulence near the low hybrid resonance. Sturman, B.I. (AN SSSR, Novosibirsk. Inst. Avtomatiki i Ehlektrometrii). *Zh. Eksp. Teor. Fiz.;* **71**: No. 2, 613-626(Aug 1976). (In Russian).

24 refs.; for English translation see the journal Sov. Phys. - JETP.

Nonlinear processes in the frequency range near the lower hybrid frequency wsub(L) are investigated. For sufficiently short-wave oscillations (kvsub(Ti)> wsub(Hi)) the main nonlinear process in a broad temperature range Tsub(e) > approximately Tsub(i), is induced scattering on electrons. The nonlinear stage of parametric instability for frequencies w> approximately wsub(L) is studied. It is shown that for a very small supercriticality the plasma wave turbulence becomes strong. Equations are derived which describe a strongly nonlinear regime. The properties of the equations are investigated.

27589 Negative absorption in an anisotropic plasma. Karapetyan, R.V. (AN SSSR, Moscow. Fizicheskij Inst.). *Zh. Tekh. Fiz.;* **46**: No. 2, 269-273(Feb 1976). (In Russian).

Electromagnetic wave absorption in a plasma with the electron drift is considered at arbitrary ratios between thermal and drift electron velocities, and also at an arbitrary value of the angle between the wave polarization vector and the direction of drift. By the kinetic equation taking account of the external field effect on the plasma particle collision process an expression has been found for the work of a high-frequency electromagnetic field with an arbitrary intensity at plasma. It is shown that within the limits of a weak field the sign of work becomes negative under certain conditions, i.e., the plasma with the electron drift can amplify the electromagnetic waves propagating in it. The expression for the amplification factor is obtained and the numerical estimation is presented.

27590 Modulation of electromagnetic waves in an isotropic inhomogeneous plasma. Dushin, L.A.; Omel'chenko, A.Ya.; Serikov, A.V. (AN Ukrainskoj SSR, Kharkov. Fiziko-Tekhnicheskij Inst.). *Ukr. Fiz. Zh. (Russ. Ed.);* **21**: No. 1, 101-106(Jan 1976). (In Russian).

The analytical relation connecting the amplitude modulation coefficient of electromagnetic waves propagating in isotropic inhomogeneous plasma with the value of density fluctuation of this plasma is obtained.

27591 Wave-wave interactions in a plasma. de Almeida, A.A.; Burgoyne, C.M. (Sao Paulo Univ. (Brazil). Instituto Astronomico e Geofisico). *Rev. Bras. Fis.;* **6**: No. 3, 345-364(1976).

The problem of the scattering of two longitudinal plasma oscillations into a single transverse wave is considered. The theory is formulated to second order in the electromagnetic field using a Vlasov type set of nonlinear equations. The emission rate and spectrum are written in terms of the electron distribution function, and the relationship between the observed emission and the dynamics of the plasma is discussed.

FUSION POWER PLANT TECHNOLOGY

27592 (CONF-771029—203) **Magnetics design for ripple-assisted beam injection into the ISX-B and TFTR Tokamaks.** Goldston, R.J.; Jassby, D.L.; Towner, H.H.; Fowler, R.H.; Lyon, J.F.; Rome, J.A.; Brown, T. (Princeton Univ., N.J. (USA). Plasma Physics Lab.; Oak Ridge National Lab., Tenn. (USA); Grumman Aerospace Corp., Bethpage, N.Y. (USA)). 1977. Contract W-7405-ENG-26. 6p. Dep. NTIS, PC A02/MF A01.

From 7. symposium on fusion research project; Knoxville, TN, USA (25 Oct 1977).

A test of ripple-assisted neutral-beam injection will be performed on the ISX-B device in 1978 to 1979, using a low-power beam with W/sub b/ approximately 10 to 20 keV, and possibly also on the TFTR device ca. 1982 with a high-power 80-keV beam. In both cases, the optimal coil configuration for establishing the required vertically asymmetric toroidal-field ripple consists of a pair of trapezoidal current loops located between the TF coils and the vacuum vessel, and bracketing the vertically injected beam. This report describes the design of the ripple coils for ISX-B, the ripple contours in the elliptical ISX-B and circular TFTR plasmas, and the objectives and parameters of the ISX-B experiment. The formation of magnetic islands in the plasma is examined for an arbitrary number of ripple-injection locations.

27593 (EUR—5602, pp 447-452) **Accessibility and replacement as prime constraints in the design of large experimental Tokamaks.** Challender, R.S. (UKAEA Reactor Group, Risley); Reynolds, P. (UKAEA Research Group, Abingdon. Culham Lab.). 1976.

From 9. symposium on fusion technology; Garmisch-Partenkirchen, F.R. Germany (14 Jun 1976).

In Proceedings of the 9. Symposium on fusion technology.

Many of the designs being developed for large Tokamak experiments are based on the classical geometry of the small machines in laboratories throughout the world: a circular array of coils interlinked by an inner toroidal vessel. An attempt is made to bring together those design features which would lead to better accessibility during non-active operation and in particular permit replacement

and repair after activation, thereby making possible an extended period of experimental operation into the ignition phase.

27594 (EUR—5602, pp 225-244) **Survey of the U.S. magnetic fusion program.** Kintner, E.E. 1976.

From 9. symposium on fusion technology; Garmisch-Partenkirchen, F.R. Germany (14 Jun 1976).

In Proceedings of the 9. Symposium on fusion technology.

An analogy between Dante's circles of Hell and the fusion program is drawn to present the US magnetic fusion program, and in particular the development of the supporting technology needed to make fusion practical. The following subjects are reviewed: confinement of plasmas, heating of plasmas, impurities in plasmas, diagnostics for plasmas, magnetic for fusion power, materials for fusion power, plasma engineering, environmental aspects of fusion, and maintainability of fusion power plants.

27595 (EUR—5602, pp 245-250) **Plan and design of ETL TPE-2 experiment.** Takeda, S.; Hakoda, K.; Hayase, K.; Hirano, Y.; Hirota, I.; Ikeda, N.; Kito, M.; Kiyama, H.; Kiyama, S.; Maejima, Y. (Electrotechnical Lab., Tanashi, Tokyo (Japan). Tanashi Branch). 1976.

From 9. symposium on fusion technology; Garmisch-Partenkirchen, F.R. Germany (14 Jun 1976).

In Proceedings of the 9. Symposium on fusion technology.

A new toroidal screw pinch experiment of electrotechnical laboratory, ETL TPE-2, which is an extension of the screw pinch experiments TPE-1 (circular cross section) and TPE-1a (non-circular cross section), is planned and designed in a large scale. The technological characteristics of TPE-2 are the aspect ratio 2.9 (major radius 40cm) and the ellipticity 1.6 of the discharge vessel which is lined with a particularly designed quartz: to obtain a high temperature plasma (approximately 400eV), capacitor banks of 80kV are provided in tandem feed for the toroidal magnetic field. A high energy density capacitor of 80kV has been developed. A highly efficient power crowbar and new preheat system have been investigated; an additional coil system is provided to reduce the irregular field and to control the dynamic motion of the plasma. The bank of this coil system has various rise time and magnitude of the current according to the pre-set program. A coil assembly reduced to a scale of one-fourth has been constructed. Measurements of magnetic fields show that magnitude of the irregular field is less than 0.5%.

27596 (EUR—5602, pp 281-286) **THOR tokamak engineering design and experimental programme.** Worsnop, P.A.; Ingram, B.S.; Hoskins, A.J.; Hoskins, A.J.; Little, P.F. (UKAEA Research Group, Abingdon. Culham Lab.). 1976.

From 9. symposium on fusion technology; Garmisch-Partenkirchen, F.R. Germany (14 Jun 1976).

In Proceedings of the 9. Symposium on fusion technology.

The THOR machine is an iron cored tokamak having a major radius of 0.52m and a minor radius of 0.17m giving an aspect ratio of 3.1. It has a low ripple toroidal field of 1T and a volt-second capability of 0.24. The maximum plasma current is expected to be in the region of 80 x 10^3A. Stabilisation of the plasma is achieved by means of a D.C. vertical field and a 1cm thick copper shell. The D.C. field is cancelled during the rise time of the plasma current by means of a pulsed reverse vertical field. Energy for the toroidal, ohmic heating and reverse vertical field systems is supplied from capacitors having a stored energy capability of 685kJ. The aims of the experimental programme include the control and study of the transition from the normal quasi-resistive tokamak regime to the low density slide-away condition. The non-Maxwellian character of the electron distribution function, typical of the slide-away regime, where strong emission around the ion plasma frequency and consequent ion heating have been observed (Alcator), will be studied by a combined transversal and tangential Thomson scattering experiment.

27597 (JAERI-M—6926) **Annual report of the Division of Thermonuclear Fusion Research, JAERI. Covering the period of April 1, 1975 to March 31, 1976.** (Japan Atomic Energy Research Inst., Tokyo). Feb 1977. 239p. Dep. NTIS (US Sales Only), PC A12/MF A01.

The JFT-2 operating regime was extended to higher toroidal field of 18 kG. Plasma confinements were studied on impurities, instabilities, plasma-wall interaction. Properties of a plasma with a separatrix magnetic surface and plasma behaviour in the scrape-off layer were studied in JFT-2a. In the diagnostics, a grazing-incidence vacuum ultra-violet spectrometer for studies on impurities was completed and put into operation. Several minor improvement and remodelling on the JFT-2 and JFT-2a tokamaks were carried out for the convenience of operation. In the plasma heating, constructions of the JFT-2 neutral injection system and the injector test stand ITS-2 for development of the higher energy ion source were started. The design of 200 kW RF power source for the plasma heating in JFT-2 was also made. Research in surface effects in fusion devices started at April 1, 1975. Experimental apparatus was designed and constructed in this fiscal year. A group for superconducting magnet development for fusion device was set up in January, 1976. Theoretical works continued in the analyses on transport processes, plasma heating, and mhd stabilities with an increasing effort on computational studies. A preliminary design of the 100 MW sub(t) tokamak experimental fusion reactor has been started in April, 1975. At the same time a conceptual design of the 2000 MW sub(t) power reactor was further improved. In the development of large tokamak device of next generation, programs on JT-60 and JT-4 are being carried out. Research and development works and detailed design studies on JT-60 are started based on the preliminary design studies made in the previous year. Preliminary design studies on JT-4 are completed.

27598 (TRITA-PFU—77-01) **Basic features of EXTRAP concept.** Lehnert, B. (Tekniska Hoegskolan, Stockholm (Sweden). Institutionen foer Plasmafysik med Fusionsforskning). Jan 1977. 42p. Dep. NTIS (US Sales Only), PC A03/MF A01.

The potentialities and properties are discussed of a recently suggested axially symmetric, quasi-steady, closed, high-beta magnetic confinement system. A toroidal pinch of non-circular cross section is immersed in the strong, inhomogeneous poloidal vacuum field from a set of ring-shaped conductors, all carrying currents in the opposite direction of the plasma current. This 'EXTRAP' concept is expected to have some important advantages, as compared to magnetic bottles based on a main toroidal field component. Concerning plasma equilibrium, there are closed local and average guiding centre orbits, beta values of order unity should become available, there is no magnetic surface splitting limit, cyclotron radiation should be kept at a comparatively low level, and bootstrap operation may become possible. Concerning plasma stability, the system should not become sensitive to magnetic island formation and asymmetries, and the short magnetic connection lengths as well as the strong vacuum field gradients should favour stabilization of flute-type, kink, and other magnetohydrodynamic modes. Concerning reactor technology, high power densities are expected to be reached, superconducting coils should not become necessary, the coil stresses are moderate, and repair and replacement are facilitated by the coil geometry. Before a final judgement can be made on this concept, however, extensive experiments and further theoretical analysis are needed.

27599 **Improvements in or relating to nuclear fusion reactors.** Farfaletti-Casali, F.; Peter, F.G.; Gritzmann, P.G. (to European Atomic Energy Community, Luxembourg). British Patent 1,483,054/A/. 17 Aug 1977. 9p.

An improved modular structure for a hollow toroidal blanket assembly for a thermonuclear reactor is described that is claimed to overcome some of the disadvantages of earlier designs. These disadvantages are discussed. The assembly, for surrounding the plasma cavity of a toroidal reactor, comprises at least two types of annular modules having different cross-sections and internal diameters, and located alternately around the toroidal chamber. Each module is subdivided in the circumferential direction into sub-modules having a uniform cross-section, the small diameter modules tapering towards the outer circumferential side whereas the larger diameter modules taper towards the inner circumferential side. The tapered portions of the modules abut along a circular path surrounding the toroidal cavity, the central axis of which path is displaced radially towards the centre of the toroid. The surfaces of the abutting portions of the smaller diameter modules may be slightly concave, whereas the corresponding portions of the larger diameter modules may be slightly convex. The modules may be provided with cooling means, such as liquid He. At least one type of module may be subdivided into four quadrant sub-modules.

27600 **Stabilized imploding liner fusion systems.** Book, D.L.; Cooper, A.L.; Ford, R.; Gerber, K.A.; Hammer, D.A.; Jenkins, D.J.; Robson, A.E.; Turchi, P.J. (Naval Research Lab., Washington, D.C. (USA)). pp 507-516 of Plasma physics and controlled nuclear fusion research 1976. Proceedings of the 6. international conference held by the IAEA at Berchtesgaden, 6-13 October 1976. Vol. 3. Vienna; IAEA (1977).

From 6. international conference on plasma physics and controlled nuclear fusion research; Berchtesgaden, F.R. Germany (6 Oct 1976).

See CONF-761012—.

A new concept in imploding liner plasma compression is described in which a liquid metal liner is imploded by pistons driven by high-pressure gas, and stability of the inner surface against Rayleigh-Taylor modes is achieved by rotation. The principle has been demonstrated by using a water liner to compress air. This 'captive liner' offers the possibility of stable, reversible implosion-expansion cycles in which the plasma energy is recovered into the driving system, leading to reactor cycles with low Q and, hence, small size. A new method of setting up closed-field confinement geometries inside a liner using a rotating electron beam is described. Plasma currents induced by the beam provide initial plasma heating and generate the containment geometry. Persistence of plasma currents 100 times longer than the beam duration has been observed. Development of these methods could lead to a very compact thermonuclear reactor operating in the manner of a reciprocating engine.

27601 High-performance non-circular tokamak power reactor design study - UWMAK-III. Conn, R.W.; Kulcinski, G.L.; Maynard, C.W. (Wisconsin Univ., Madison (USA). Dept. of Nuclear Engineering) (and others). pp 203-220 of Plasma physics and controlled nuclear fusion research 1976. Proceedings of the 6. international conference held by the IAEA at Berchtesgaden, 6-13 October 1976. Vol. 3. Vienna; IAEA (1977).

From 6. international conference on plasma physics and controlled nuclear fusion research; Berchtesgaden, F.R. Germany (6 Oct 1976).

See CONF-761012—.

UWMAK-III is a conceptual power reactor design study aimed at understanding the problems associated with using advanced technologies and several new or different design approaches in tokamak systems. Advanced technologies studied include the use of the molybdenum-based alloy, TZM, as the primary structural material, the use of aluminium as the stabilizer and aluminium alloy structure for the NbTi superconducting magnets, and the use of a closed-cycle helium gas turbine power conversion system. New or different design approaches include the study of RF (fast magnetosonic waves) plasma heating, a blanket design where tritium breeding is accomplished only in the outer blanket region, a permanent inner blanket that is basically a hot shield, tritium extraction and recycling processes, and the general design approach to blanket module removal. The maximum module weight is only 42t. An MHD analysis has determined the non-circular plasma shaped like a characteristic "D" with neutral points on the plasma boundary for a poloidal divertor. The reactor is small (major radius=8.1 m) with a relatively high β (about 9%) and an average neutron wall loading of 2.5 MWm^{-2}. It is designed to generate 5000 MW(th) during the burn and 1985 MW(e) continuously. The net plant efficiency is about 42%. Aspects of the design study discussed in some detail include the plasma physics analysis, magnet design, blanket and shield neutronic and thermal analyses, tritium extraction, materials performance and radiation damage. A brief discussion is included on the questions of size and costs in tokamak systems and their approximate relation to other advanced power-generating technologies.

27602 Mirror reactor studies. Moir, R.W.; Barr, W.L.; Bender, D.J. (California Univ., Livermore (USA). Lawrence Livermore Lab.) (and others). pp 223-235 of Plasma physics and controlled nuclear fusion research 1976. Proceedings of the 6. international conference held by the IAEA at Berchtesgaden, 6-13 October 1976. Vol. 3. Vienna; IAEA (1977).

From 6. international conference on plasma physics and controlled nuclear fusion research; Berchtesgaden, F.R. Germany (6 Oct 1976).

See CONF-761012—.

Design studies of a fusion mirror reactor, a fusion-fission mirror reactor, and two small mirror reactors are summarized. The fusion reactor uses 150-keV neutral-beam injectors based on the acceleration of negative ions. The injectors provide over 1 GW of continuous power at an efficiency greater than 80%. The fusion reactor has three-stage, modularized, Venetian blind, plasma direct converter with a predicted efficiency of 59% and a new concept for removal of the lune-shaped blanket: a crane is brought between the two halves of the Yin-Yang magnet, which are separated by a float. The design has desirable features such as steady-state operation, minimal impurity problems, and low first-wall thermal stress. The major disadvantage is low Q resulting in high re-circulating power and hence high cost of electrical power. However, the direct capital cost per unit of gross electrical power is reasonable [$1000/kW(e)]. By contrast, the fusion-fission reactor design is not penalized by re-circulating power and uses relatively near-term fusion technology being developed for the fusion power program. New results are presented on the Th-^{233}U and the U-^{239}Pu fuel cycles. The purpose of this hybrid is fuel production, with projected costs at $55/g of Pu or $127/g of ^{233}U. Blanket and cooling system designs, including an emergency cooling system, by General Atomic Company, lead us to the opinion that the reactor can meet expected safety standards for licensing. The smallest mirror reactor having only a shield between the plasma and the coil is the 4.2-m long fusion engineering research facility (FERF) designed for material irradiation. The smallest mirror reactor having both a blanket and shield is the 7.5-m long experimental power reactor (EPR), which has both a fusion and a fusion-fission version.

27603 Summary of reactor systems. Schmitter, K.H. (Max-Planck-Institut fuer Plasmaphysik, Garching/Muenchen (Germany, F.R.)). pp 571-574 of Plasma physics and controlled nuclear fusion research 1976. Proceedings of the 6. international conference held by the IAEA at Berchtesgaden, 6-13 October 1976. Vol. 3. Vienna; IAEA (1977).

From 6. international conference on plasma physics and controlled nuclear fusion research; Berchtesgaden, F.R. Germany (6 Oct 1976).

See CONF-761012—.

27604 Conceptual fusion reactor based on the high-plasma-density Z-pinch. Hartman, C.W.; Carlson, G.; Hoffman, M.; Werner, R. (California Univ., Livermore (USA). Lawrence Livermore Lab.); Cheng, D.Y. (Santa Clara Univ., Calif. (USA)). *Nucl. Fusion;* **17**: No. 5, 909-918(1977).

Conceptual DT and DD fusion reactors are discussed based on magnetic confinement with the high-plasma-density Z-pinch. The reactor concepts have no "first wall", the fusion neutrons and plasma energy being absorbed directly into a surrounding lithium vortex blanket. Efficient systems with low re-circulated power are projected, based on a flow-through pinch cycle for which overall Q values can approach 10. The conceptual reactors are characterized by simplicity, small minimum size (100MW(e)) and by the potential for minimal radioactivity hazards.

27605 Simple neoclassical point model for transport and scaling in EBT. Hedrick, C.L.; Jaeger, E.F.; Spong, D.A. (Oak Ridge National Lab., Tenn. (USA)); Guest, G.E. (General Atomic Co., San Diego, Calif. (USA)); Krall, N.A.; McBride, J.B.; Stuart, G.W. (Science Applications, Inc., La Jolla, Calif. (USA)). *Nucl. Fusion;* **17**: No. 6, 1237-1243(1977).

A simple neoclassical point model is presented for the ELMO Bumpy Torus experiment. Solutions for steady state are derived. Comparison with experimental observations is made and reasonable agreement is obtained.

27606 Uragan-2 experimental thermonuclear device of stellarator type. Amelin, V.Z.; Biryukov, O.V.; Vishnevetskii, V.N.; Geogievskii, A.V.; Gorokhov, V.P. (AN Ukrainskoj SSR, Kharkov. Fiziko-Tekhnicheskij Inst.). *Ukr. Fiz. Zh. (Russ. Ed.);* **21**: No. 3, 422-426(Mar 1976). (In Russian).

For English translation see the journal Ukr. Phys. J.

Main principles are stated which form the basis for modernization of stellarator-race-track URAGAN-1 M named URAGAN-2 (Y-2). In this machine longitudinal magnetic field H_0 is increased from 10 to 20 kOe, which made possible to conduct experiments aimed at studying and confining a more hot and dense plasma (n approximately $10^{13}cm^{-3}$, T approximately 1 keV). The constructive and technological developments which were tested in constructing the units of Y-2 are briefly described.

27607 High beta stellarator, a toroidal confinement system. Kaufmann, M. (Commission of the European Communities, Garching (Germany F.R.). Institut fuer Plamaphysik). pp 5-12 of Pulsed high beta plasmas. Proceedings of the third topical conference held at UKAEA Culham Laboratory, Abingdon, Oxfordshire, UK 9-12 September 1975. Evans, D.E. (ed.). Oxford; Pergamon Press (1976).

From 3. topical conference on pulsed high beta plasmas; Abingdon, Oxfordshire, UK (9 Sep 1975).

See CONF-750944—.

A review is given of progress in theory and experiment since the first proposal in 1962 that high-beta stellarators should be investigated. The main theoretical points and the results from linear and toroidal experiments are surveyed. Recent studies on Scyllac (at Los Alamos) and ISAR 1 (at Garching) are more fully presented. For toroidal equilibrium and the m = 1 mode, nearly quantitative agreement of experiment with theory has been found; feedback stabilization and wall stabilization in present and future experiments respectively are now possibilities.

BLANKET ENGINEERING

27608 (CEA-CONF—3860) Alumina-plasma interaction in the PETULA Tokamak. Bardet, R.; Bernard, M.; Briffod, G. (Association Euratom-CEA, Centre d'Etudes Nucleaires de Grenoble, 38 (France). Groupe de Recherches sur la Fusion Controlee; CEA Centre d'Etudes Nucleaires de Grenoble, 38 (France). Service d'Ionique Generale). 1976. 19p. (In French). (CONF-761232—6). Dep. NTIS (US Sales Only), PC A02/MF A01.

From National congress on plasma physics; Paris, France (6 Dec 1976).

In connection with the construction of an alumina vacuum vessel on the PETULA Tokamak, measurements of the outgassing properties of alumina and studies of alumina-plasma interaction have been undertaken. Outgassing rates of 10^{-11} to 10^{-12} Torr l/scm^2 are achieved for baking temperature ranging between 150° and 200° C. Two categories of results have been obtained from the studies of alumina-plasma interaction depending on the plasma interacting with the alumina. For dense and cold plasma $10^{13}e/cm^3$ a few eV, impurity concentrations lower than 1% are measured -ELISA experiment. For dense and hot plasmas, comparison between discharges produced with tungsten and alumina limiters shows an improvement of plasma characteristics in the case of alumina: ohmic power and oxygen contamination are significantly reduced.

27609 (EUR—5602, pp 665-671) Neutron streaming problems in the 'FINTOR 1' design. Burn, K.; Canali, U.; Cuniberti, R.; Nicks, R.; Ponti, C.; Realini, G.; Heusden, R. van (Commission of the European Communities, Ispra (Italy). Joint Research Centre). 1976.

From 9. symposium on fusion technology; Garmisch-Partenkirchen, F.R. Germany (14 Jun 1976).

In Proceedings of the 9. Symposium on fusion technology.

The conceptual design of a minimum size experimental fusion reactor of the TOKAMAK-type (FINTOR) is in progress within the framework of a collaboration agreement between CNEN-Frascati, JRC-Ispra and the University of Naples. In this reactor the major problem, from the neutronic point of view, is the design of a minimum thickness shield which fulfils the requirement of reducing the damage and heat deposition in the superconducting coils to acceptable values. In order to improve the design of the neutron and gamma shielding including the real configuration of the blanket and the presence of divertor slots and neutral injectors a Monte Carlo analysis of the neutron streaming has been performed by means of MORSE-E code. Results of the streaming effects on the neutron damage in the superconductors coils and of the evaluation of neutron fluxes in the injectors are reported.

27610 (EUR—5602, pp 551-556) **Survey on experimental neutron physics of CTR blankets in the KFA.** Hecker, R.; Cloth, P.; Filges, D. (Kernforschungsanlage Juelich G.m.b.H. (Germany, F.R.). Inst. fuer Reaktorentwicklung). 1976.

From 9. symposium on fusion technology; Garmisch-Partenkirchen, F.R. Germany (14 Jun 1976).

In Proceedings of the 9. Symposium on fusion technology.

The research program of the KFA on neutronic CTR-blanket problems is described by examples of experiments on blanket-model assemblies. The work is in strong correlation with theoretical evaluations of the problems. The main objective is the experimental test of nuclear data and calculational methods by comparison of the results. The properties of the experimental blanket models used are derived from the existing CTR conceptual design studies and from the theory of neutron fields. The limitations of the present blanket experiments are discussed. The development of appropriate measuring techniques is also described.

27611 (EUR-CEA-FC—889) **Plasma-wall interactions in the TFR machine.** (Association Euratom-CEA, Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France). Groupe de Recherches sur la Fusion Controlee; CEA Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France). Dept. de Protection). Mar 1977. 32p. (In French). (CONF-761232—5). Dep. NTIS (US Sales Only), PC A03/MF A01.

From National congress on plasma physics; Paris, France (6 Dec 1976).

The impurities contained inside the TFR plasma were identified from spectroscopy and their behavior inside the plasma was investigated: the time dependence of the growth of some oxygen lines (the leading impurity) from the beginning of the discharge and radial profiles of the 117A line emission from Mo^{30+} ion are given. Passive measurements were associated to measurements after cold oxygen injection. The electron and ion induced desorption seems to originate the pollution by light impurities. At the beginning of the discharge the oxygen would be produced from the bombardment of the walls by atoms and nonconfined charged particles. Heavy impurities are not exclusively produced from the limiter but are also due to the wall sputtering by atoms and ions from the plasma.

27612 (EUR-CEA-FC—893) **Description of the fast moving limiter used with T.F.R.** Bonnel, P.; Dei-Cas, R. (Association Euratom-CEA sur la Fusion, Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France). Dept. de Physique du Plasma et de la Fusion Controlee). May 1977. 20p. (In French). Dep. NTIS (US Sales Only), PC A02/MF A01.

Trials were made in view of modifying the conditions of discharge initiation by limiting the plasma radius with using a metal limiter of small surface so as to reduce the plasma-wall interaction in the phase of current build-up. This limiter, 25cm in diameter, is moved along a 10-15 cm path in 10-20 milliseconds. It consists in a 1kg molybdenum plate supported by a carrier driven by a fast jack. The preliminary results obtained with plasma are rather good.

27613 (JAERI-M—6971) **Diagnostics of a scrape-off layer plasma.** Kimura, H.; Nagami, M.; Yamamoto, S.; Ueda, N.; Ohtsuka, H. (Japan Atomic Energy Research Inst., Tokyo). Mar 1977. 26p. Dep. NTIS (US Sales Only), PC A03/MF A01.

The methods measuring a scrape-off layer plasma of DIVA (JFT-2a) are reviewed. In conclusion, these all should be effective in the next-generation devices with divertor.

27614 (JAERI-M—7013) **Heat analysis of the magnetic limiter plate for JT-60.** Nakamura, H.; Ninomiya, H.; Shimizu, M.; Ohta, M. (Japan Atomic Energy Research Inst., Tokyo). Mar 1977. 47p. (In Japanese). Dep. NTIS (US Sales Only), PC A04/MF A01.

Heat analysis has been made of the magnetic limiter plate for JT-60. Test materials of the magnetic limiter plate are molybdenum, graphite, pyrolytic graphite and silicon carbide. It is assumed in calculation of the heat analysis that 10MW is deposited on the 2 cm wide surface of the magnetic limiter plate in about 10 sec. The magnetic limiter plate of pyrolytic graphite is a stack of pyrolytic graphite sheets, heat input is in the deposition plane to take advantage of the large heat conductivity along this plane. Pyrolytic graphite is the best in terms of temperature rise. The temperature of molybdenum and graphite rise up to 1800°C and 620°C, respectively, in an deposition of 10 MWx10sec. Silicon carbide is not suitable for the magnetic limiter plate. Because the plasma of the JT-60 discharges every 10 min, the average heat flux decreases to 17 w/cm^2 during the each interval. When the magnetic limiter plate has the above heat inflow, a maximum of above 1000°C occurs at the edge far from the joint to the thick ring of the vacuum vessel. To reduce heat load of the magnetic limiter plate, an alternating current (2 -- 5Hz) is superposed on the magnetic limiter coil current. The intersection of separatrix line and magnetic limiter plate then moves cyclically more than 10 cm. Concerning temperature distribution of the multi-groove magnetic limiter plate, its dimensions are determined by the limitation in vapor pressure to prevent the impurity inflow.

27615 (JAERI-M—7014) **Effect of plasma minor-radius expansion in the current build-up phase of a large tokamak.** Kobayashi, T.; Tazima, T.; Tani, K.; Tamura, S. (Japan Atomic Energy Research Inst., Tokyo). Mar 1977. 23p. (In Japanese). Dep. NTIS (US Sales Only), PC A03/MF A01.

A plasma simulation code has been developed to study the plasma current build-up process in JT-60. Plasma simulation is made with a model which represents well overall plasma behavior of the present-day tokamaks. The external electric circuit is taken into consideration in simulation calculation. An emphasis is placed on the simulation of minor-radius expansion of the plasma and behavior of neutral particles in the plasma during current build-up. A calculation with typical parameters of JT-60 shows a week skin distribution in the current density and the electron temperature, if the minor radius of the plasma expands with build-up of the plasma current.

27616 (LA-UR—77-2511) **TRIDENT: a new triangular mesh discrete ordinates code.** Seed, T.J.; Miller, W.F. Jr.; Bosler, G.E. (Los Alamos Scientific Lab., N.Mex. (USA)). 1978. Contract W-7405-ENG-36. 6p. (CONF-780401—1). Dep. NTIS, PC A02/MF A01.

From Topical meeting on advances in reactor physics; Gatlinburg, TN, USA (9 Apr 1978).

TRIDENT, a newly released discrete-ordinates computer code, solves the two-dimensional static, multigroup neutron transport equation in x-y and r-z geometries within a general domain having material boundaries that are not necessarily parallel to coordinate axes. The spatial discretization is accomplished using triangular finite elements and piecewise linear trial functions. The x-y geometry triangles allow the user to accurately model hexagonal lattices, square cells containing circular rods, and complicated shield configurations. With r-z geometry triangles, toroidal geometry problems of importance to Tokamak designs can be solved even for cases of elliptic or general irregular cross sections. The r-z geometry triangles are also useful for modeling complicated cylindrical shield configurations. An additional feature of TRIDENT is an option to mitigate or, if desired by the user, eliminate the ray effect.

27617 (ORNL/TM—5960) **ORNL fusion power demonstration study: fluid flow, heat transfer, and stress analysis considerations in the design of blankets for full-scale fusion reactors.** Fraas, A.P.; Thompson, A.S. (Oak Ridge National Lab., Tenn. (USA)). Feb 1978. Contract W-7405-ENG-26. 110p. Dep. NTIS, PC A06/MF A01.

The complex and subtle interplay of conditions imposed on fusion reactor blanket designs by heat transfer, coolant flow, thermal stress, fabrication, and maintenance considerations has been examined for a series of representative cases taken from the literature. In view of the difficulties with thermal stress cracking, wall melting, and vaporization that have been experienced in tokamak experiments, particular attention has been given to possible hot spot effects that might stem from aberrant behavior of the plasma. The results of the study indicate that a lithium-cooled niobium blanket structure will withstand ten to twenty times more severe first wall heating conditions than a helium-cooled stainless steel structure. This raises a number of serious problems relative to magnetohydrodynamic effects, and methods for coping with these are outlined. The blanket design employing a recirculating lithium-cooled niobium structure that appeared most promising from the heat transfer, stress analysis, and coolant flow standpoints is then reviewed from the standpoints of fabricability, cost, and maintenance and found to be competitive with or superior to the several helium-cooled blanket designs considered in the study. A number of major questions are pointed out and experiments are recommended that should help to resolve the basic uncertainties and provide a sound basis for key design decisions.

27618 (UWFDM—202) **Use and performance of graphite and metal ISSECs in tokamak fusion reactors.** Avci, H.I.; Gohar, Y.; Sung, T.Y.; Kulcinski, G.L.; Maynard, C.W. (Wisconsin Univ.,

Madison (USA). Dept. of Nuclear Engineering). Apr 1977. Contract EY-76-S-02-2272. 103p. Dep. NTIS, PC A06/MF A01.

The ISSEC (Internal Spectral Shifter and Energy Converter) concept is expanded to the area of high temperature refractory metals. The effects are studied in a cylindrical geometry blanket model and the effects of breeding tritium are included. The more realistic mechanical and heat transfer design characteristics of ISSECs are dealt with. A description of the way the calculations were carried out is given and the model blanket design used is presented. The way various ISSECs affect the 316 SS first structural wall radiation damage parameters is shown. The effects of ISSECs on the parameters characterizing the whole blanket, e.g., tritium breeding ratio, energy multiplication, radioactivity are outlined. The radiation damage inside the ISSECs themselves is elaborated on. How an ISSEC might mechanically be constructed is investigated, as well as the associated heat transfer and stress problems. Some other considerations that might affect the choice of an ISSEC material are detailed, such as: cost and availability, vacuum properties, chemical activity, sputtering, and thermal shock properties. (MHR)

27619 (UWFDM—205) **Effect of a liquid ISSEC on radiation damage parameters in laser fusion reactor first walls.** Avci, H.I.; Kulcinski, G.L. (Wisconsin Univ., Madison (USA). Dept. of Nuclear Engineering). Apr 1977. Contract EY-76-S-02-2272. 37p. Dep. NTIS, PC A03/MF A01.

The effectiveness of a liquid Li ISSEC is analyzed and it is compared briefly to a solid C, V, Nb, Mo, and W ISSEC in terms of displacement damage and gas generation in the first walls. In addition a liquid Pb (or Pb_4Li) ISSEC is proposed which may have more desirable characteristics without sacrificing important parameters such as breeding ratio. (MHR)

27620 (UWFDM—208) **Comparison of liquid ISSECs; Li, Pb, and Pb_4Li for use in laser fusion reactors.** Avci, H.I.; Kulcinski, G.L. (Wisconsin Univ., Madison (USA). Dept. of Nuclear Engineering). 27 May 1977. Contract EY-76-S-02-2272. 24p. Dep. NTIS, PC A02/MF A01.

The use of a lead-lithium compound as an ISSEC (Internal Spectral Shifter and Energy Converter) is studied using both the high energy multiplication capability of lead and the high tritium breeding from lithium. The effectiveness of Pb_4Li ISSEC is compared to the effectiveness of pure Li and Pb ISSEC cases. It is concluded that Pb_4Li is best liquid ISSEC material and the thickness to be used is 50 to 75 cm. (MHR)

27621 (WFPS-TME—055) **Compact poloidal divertor reference design for TNS.** Yang, T.F.; Lee, A.Y.; Ruck, G.W.; Lange, W.J. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Fusion Power Systems Dept.). 30 Sep 1977. Contract W-7405-ENG-26. 32p. (CONF-771029—207). Dep. NTIS, PC A03/MF A01.

From 7. symposium on fusion research project; Knoxville, TN, USA (25 Oct 1977).

A compact poloidal divertor concept has been developed for TNS tokamaks and its feasibility has been demonstrated by sufficient detailed magnetic, thermal, mechanical and vacuum analyses. This particular divertor is formed by a pair of opposing coil sets which define a magnetic flux slot where the particle burial chamber is located. The magnetic flux in the space between the coil sets is compressed vertically to limit the height and to expand the horizontal width of the particle and energy burial chamber. The intensity of the poloidal field is increased to make the pitch angle of the flux lines very large so that the diverted particles can be intercepted by a large number of panels oriented at a small angle with respect to the flux lines. Large collecting surface areas can be obtained so that the thermal load and particle flux are reduced to a practical level. Flowing lithium film and solid metal panels have been considered as the particle collector and the latter is preferred. This divertor allows for most economical use of the available space inside the TF coils and thus has minor impact on the overall size of the tokamak. The divertor design is essentially independent of the tokamak system, although analyses were performed based on TNS.

27622 Absolute fission-rate distributions in lithium and hybrid fusion blanket assemblies, (2). Analysis and evaluation. Seki, Y.; Maekawa, H. (Japan Atomic Energy Research Inst., Tokai, Ibaraki. Tokai Research Establishment). *J. Nucl. Sci. Technol. (Tokyo);* **14**: No. 3, 210-225(Mar 1977).

The absolute fission rates of ^{235}U, ^{237}Np, ^{238}U and ^{232}Th were measured in four types of spherical blanket assemblies containing lithium and/or natural uranium and/or graphite. The results of measurement are compared with those of one-dimensional transport calculations employing 100-group neutron cross-sections obtained from the ENDF/B-IV data file. It is shown that the ratios between calculated and experimental values of ^{232}Th, ^{238}U and ^{237}Np fission rates decrease with distance from the assembly center, where D-T neutrons are generated. An overestimation of about 50% is observed in the calculated ^{235}U fission rate for the graphite reflector region. One of the main sources of the disagreement proves to lie in the inability of the codes adopted for generating the multi-group cross-section to take account of the angular distributions of the secondary neutrons emanating from nonelastic reactions. The results of the analysis indicate that the method of calculation currently employed in fusion reactor neutronics overestimates the reflection of neutrons and underestimates the penetration of fast neutrons when a graphite reflector is used.

27623 Oxygen gas injection during the current plateau of a TFR tokamak plasma. *Nucl. Fusion;* **17**: No. 6, 1297-1312(1977).

The results of experiments in which oxygen gas is injected at the current plateau of a quasi-stationary TFR deuterium plasma are presented. As a consequence of the injection, the molybdenum density in the plasma decreases, apparently because of a decreased molybdenum flux entering the plasma. This density decrease has a time constant which is a measure of the impurity particle confinement time tausub(p). In this way, tausub(p) approximately equal to 50ms is found at the plasma centre, and tausub(p) approximately equal to 20ms at the periphery. The discharges studied have been simulated by using different forms of anomalous impurity diffusion. It is concluded that, for the conditions imposed by the experiments, it is necessary to use anomalous diffusion proportional to the impurity density gradients.

27624 Plasma power balance models for self-sustained tokamak reactors. Bertolini, E. (JET Design Group, Culham Lab., Abingdon, United Kingdom); Engelmann, F. (Stichting voor Fundamenteel Onderzoek der Materie, Jutphaas (Netherlands). Instituut voor Plasma-Fysica); Hoffman, M.A. (California Univ., Davis (USA). Coll. of Engineering); Taroni, A. (Comitato Nazionale per l'Energia Nucleare, Bologna (Italy). Centro di Calcolo). *Nucl. Fusion;* **17**: No. 5, 955-968(1977).

The plasma physics and engineering constraints determining the minimum size of a tokamak reactor are analysed. Three different models of increasing complexity are considered: (1) a simplified plasma-engineering model for a preliminary choice of the parameters, (2) a self-consistent model based on a space-averaged (zero-dimensional) plasma power balance, and (3) a self-consistent model including the profile effects on the power balance as provided by the Duechs code. As a reference example, the parameters of a minimum-size experimental reactor (FINTOR 1) are deduced, assuming that plasma confinement not worse than 10 times below neoclassical is possible and adopting conservative technological feasibility conditions. The main parameters resulting are a minor plasma radius a=2.25m, an aspect ratio A=4 and a magnetic field on axis of Bsub(To)=3.5T. A sensitivity analysis of the effects of changes in the main input parameters is performed. As an example of a different assumption on plasma transport, the case of losses induced by the trapped-ion instability is touched upon. The method exposed can readily be used to deduce the parameters of reactors of given (not minimum) power or wall loading.

27625 High-density discharges with gettered torus walls in DITE. Fielding, S.J.; Hugill, J.; McCracken, G.M.; Paul, J.W.M.; Prentice, R.; Stott, P.E. (UKAEA Research Group, Abingdon. Culham Lab.). *Nucl. Fusion;* **17**: No. 6, 1382-1385(1977).

This paper deals with high-density discharges with gettered torus walls. Curves on the development of hydrogen and deuterium discharges and for the main plasma parameters are given.

27626 Fusion product bombardment of a tokamak first wall. Hively, L.M.; Miley, G.H. (Illinois Univ., Urbana (USA). Fusion Studies Lab.). *Nucl. Fusion;* **17**: No. 5, 1031-1046(1977).

A method of calculating the wall loading due to fusion products escaping from the plasma in a tokamak is described. For this purpose, the small-banana-width approximation is eliminated, yielding an analytic formulation for high-energy orbits and associated loss-cone limits. Wall-loading profiles (as a function of poloidal angle) are presented for various experimental devices (PLT, TFTR, and ORNL-EPR) and for a typical reactor (UWMAK-I). Peak-to-average alpha flux ratios of the order of 1.4 to 2.3 combined with average fluxes of approximately 10^{11} alphas per cm^2 per second, suggest that localized blistering may be a serious source of impurity atoms as well as a wall erosion mechanism. Special wall panels in regions of high flux are suggested. Other implications include a unique suggestion for fuel injection along special orbits intercepted via a bundle divertor.

27627 Calculations of impurity radiation and its effects on tokamak experiments. Jensen, R.V.; Post, D.E. (Princeton Univ., N.J. (USA). Plasma Physics Lab.); Grasberger, W.H.; Tarter, C.B.; Lokke, W.A. (California Univ., Livermore (USA). Lawrence Livermore Lab.). *Nucl. Fusion;* **17**: No. 6, 1187-1196(1977).

The impurity radiation for typical tokamak parameters has been numerically calculated using an "average- ion model". Coronal equilibrium values for the emission of oxygen, iron, molybdenum, tungsten and gold were determined from the steady-state solutions of a set of related rate equations which included the effects of electron collisional ionization and excitation, dielectronic and radiative re-

combination, $\Delta n=0$ and Δn except 0 line transitions, and bremsstrahlung. The results for oxygen, iron, and molybdenum compare very well with other calculations. Since impurities diffusing in a tokamak are not expected to be in coronal equilibrium, time-dependent radiation calculations were also performed. A comparison of these non-equilibrium loss rates with those calculated under the assumption of coronal equilibrium indicates that coronal radiation calculations do not significantly underestimate the moderate-and high-Z impurity radiation losses for neoclassical diffusion velocities in large tokamaks, such as Princeton Large Torus and Tokamak Fusion Test Reactor. Finally, the detailed steady-state emission rates were used to investigate the effects of various concentrations of impurities on the nsub(e)tau requirements for breakeven, ignition, and $Q=5$ beam-driven reactor experiments.

27628 Trapping and removal of oxygen in tokamaks. Oren, L.; Taylor, R.J. (California Univ., Los Angeles (USA). Plasma Physics Group). *Nucl. Fusion;* **17**: No. 6, 1143-1151(1977).

Various discharge cleaning techniques have been studied in Microtor. It was found that high-temperature discharges are not only ineffective in reducing the oxygen on the wall, and hence in the plasma, but may even induce trapping. Oxygen can be removed from the wall by a low-temperature, partially ionized hydrogen plasma by conversion to water vapour. The amount of loosely bound oxygen on the surface is thus reduced below 1% of a monolayer. The residual amount of the oxygen in the plasma is near 10^{10}atomcm^{-3}, and represents a significant improvement over previous tokamak results.

27629 Model for heavy-impurity re-cycling at a limiter and limitation of power loss to a limiter in tokamaks. Shimomura, Y. (Japan Atomic Energy Research Inst., Tokai, Ibaraki. Tokai Research Establishment). *Nucl. Fusion;* **17**: No. 6, 1377-1381(1977).

This paper describes a mathematical model for heavy-impurity re-cycling at the limiter of a tokamak. It also deals with the limitation of the energy losses due to contamination mechanisms. Essentially the three following mechanisms are studied: Evaporation; sputtering by charge-exchange particles; sputtering by ions. A comparison with experimental results is also given.

27630 Tokamak boundary in contact with a limiter. Waltz, R.E.; Burrell, K.H. (General Atomic Co., San Diego, Calif. (USA)). *Nucl. Fusion;* **17**: No. 5, 1001-1014(1977).

A theoretical and computational study of a tokamak boundary in contact with a limiter is given. Parallel field flows of plasma and heat induced by the sheath conditions at the limiter are treated with model sources and sinks in the cross-field transport equations. A charge-exchange neutral code is used for the re-cycled neutrals. It is found that the boundary conditions at the limiter radius have little effect on the energy flow to the boundary unless the ionization zone is well attached to the limiter. Exemplary heuristic boundary conditions useful for transport codes are given. The partitions of particle and energy flow to the limiter and wall are discussed.

MAGNET COILS AND FIELDS

REFER ALSO TO CITATION(S) 27648

27631 (CLM-R—165) **Reversal of the toroidal magnetic field in pinches.** Butt, E.P.; Firth, L.; Gribble, R.F.; An, L.Y.; Newton, A.A.; Verhage, A.J.L. (SEE ALSO- 6413010 UKAEA Research Group, Abingdon. Culham Lab.). May 1977. 29p. Dep. NTIS (US Sales Only), PC A03/MF A01.

Developments in the understanding of the reverse field pinch as a relaxed state having a near minimum magnetic energy content are reviewed. Experimental results from ZETA and HBTX I show that plasmas tend to relax towards the above state, and self-reversal of the toroidal field is observed. The self reversal phenomenon has also been investigated on FRSX and a 3.5 m linear pinch having the same parameters. Results from all these experiments are reviewed and discussed.

27632 (IPPJ-T—25) **Stress analysis of supporting tube of helical winding in stellarator device.** Miyamoto, K. (Nagoya Univ. (Japan). Inst. of Plasma Physics). Jun 1976. 12p. Dep. NTIS (US Sales Only), PC A02/MF A01.

In stellarator devices, the strong magnetic forces act on the helical coils due to the interaction of the helical coil currents and the toroidal field. When the helical coils are supported by a cylinder tube, the internal stresses in the supporting tube become critical value for the supporting material. The analytical results of the stress and the displacement are presented in the case of linear stellarator with helical symmetry.

27633 (JAERI-M—6802) **Design study of superconducting poloidal magnets for tokamak fusion power reactor.** (Japan Atomic Energy Research Inst., Tokyo). Jan 1977. 135p. (In Japanese). Dep. NTIS (US Sales Only), PC A07/MF A01.

Design study of the superconducting poloidal magnets for a tokamak fusion power reactor has been carried out. The purpose is to clearify engineering problems in development of the superconducting poloidal magnets. Performed here were electrical design, stress analysis of electromagnetic forces, design of superconducting wires, calculation of heat generated in superconducting coils by pulsive current, design of the cryostat and its heat-leak calculation and design of refrigeration system. As the result, the need for further study was indicated in the following areas: supports of coils against electromagnetic forces, structure of low-eddy-current cryostat and circulation of liquid helium in superconducting coils.

27634 (JAERI-M—6921) **Design study of superconducting toroidal field magnet for tokamak fusion power reactor.** (Japan Atomic Energy Research Inst., Tokyo). Feb 1977. 146p. (In Japanese). Dep. NTIS (US Sales Only), PC A08/MF A01.

Design study of the superconducting toroidal field magnet for a 2000 MW sub(t) tokamak fusion power reactor has been carried out. Performed here were conductor design, magnetic field calculation, design of coil support, stress analysis and design of refrigeration system. The maximum toroidal field at the coil is 12T, providing 6T at the plasma center. Nb_3Sn superconductors are employed in the higher field zone. The operation current is 34.72 kA, and the conductors are fully stabilized. The heat load in the magnet is 21.1 kW, and the required liquefaction rate is 36,000 l/h. Many technological problems were revealed by the design study.

27635 (JAERI-M—6953) **Eddy currents induced on the torus with non-uniform resistances.** Kameari, A.; Ninomiya, H.; Suzuki, Y. (Japan Atomic Energy Research Inst., Tokyo). Feb 1977. 25p. (In Japanese). Dep. NTIS (US Sales Only), PC A02/MF A01.

In the design study of the large scale tokamak devices, the interaction between the eddy current in the vacuum vessel and the strong toroidal magnetic field is an important factor to be considered. A new method is developed to analyze the eddy current problem more generally. Eddy currents induced in the vacuum vessel torus with non-uniform electric resistances have been studied. The vacuum vessel is approximated by a thin torus of circular cross section with the electric resistances varying periodically in the toroidal direction. The currents on the torus are represented by Fourier series expansion and the electro-magnetic couplings with surrounding coils and plasma column are taken into consideration. Toroidal effect is introduced by expansion of the reciprocal aspect ratio. The eddy currents in the vacuum vessel during both the startup and the shutdown phase of the discharge with major radius shift of the plasma column are calculated, especially the "saddle" distribution of current densities which flows in closed loops inside the thick sectors.

27636 (ORNL/TM—6032) **Large coil test facility conceptual design report.** Nelms, L.W.; Thompson, P.B.; Mann, T.L. (Oak Ridge National Lab., Tenn. (USA)). Feb 1978. Contract W-7405-ENG-26. 137p. Dep. NTIS, PC A07/MF A01.

In the development of a superconducting toroidal field (TF) magnet for The Next Step (TNS) tokamak reactor, several different TF coils, about half TNS size, will be built and tested to permit selection of a design and fabrication procedure for full-scale TNS coils. A conceptual design has been completed for a facility to test D-shaped TF coils, 2.5 x 3.5-m bore, operating at 4-6 K, cooled either by boiling helium or by forced-flow supercritical helium. Up to six coils can be accommodated in a toroidal array housed in a single vacuum tank. The principal components and systems in the facility are an 11-m vacuum tank, a test stand providing structural support and service connections for the coils, a liquid nitrogen system, a system providing helium both as saturated liquid and at supercritical pressure, coils to produce a pulsed vertical field at any selected test coil position, coil power supplies, process instrumentation and control, coil diagnostics, and a data acquisition and handling system. The test stand structure is composed of a central bucking post, a base structure, and two horizontal torque rings. The coils are bolted to the bucking post, which transmits all gravity loads to the base structure. The torque ring structure, consisting of beams between adjacent coils, acts with the bucking structure to react all the magnetic loads that occur when the coils are energized. Liquid helium is used to cool the test stand structure to 5 K to minimize heat conduction to the coils. Liquid nitrogen is used to precool gaseous helium during system cooldown and to provide thermal radiation shielding.

27637 (ORNL/TM—6150) **ORNL TNS Program: plasma engineering considerations and innovations for a medium field tokamak fusion reactor.** Peng, Y.K.M.; Attenberger, S.E.; Houlberg, W.A.; Mense, A.T.; Rome, J.A.; Uckan, N.A. (Oak Ridge National Lab., Tenn. (USA)). Dec 1977. Contract W-7405-ENG-26. 30p. Dep. NTIS, PC A03/MF A01.

Recent plasma engineering studies have ascertained a viable concept for The Next Step (TNS) reactor based on medium toroidal fields between 4 T and 7 T at the plasma center, plasma anti β values up to 10%, and averaged densities between 0.6×10^{14} cm^{-3} and 2.5 x

10^{14} cm^{-3}. Plasma engineering innovations that can substantially reduce the size, cost, and complexity of the TNS reactor have been explored and are summarized. It is shown that the previously anticipated requirement of high pellet velocities can be substantially reduced; the toroidal field (TF) ripple requirements may be relaxed to reduce the number of TF coils and improve machine access; hybrid equilibrium field (EF) coils have been shown to require building only small interior coils and to reduce the power supply required by the exterior coils; proper approaches of microwave plasma preheating may reduce the peak loop voltage for start-up by an order of magnitude. The medium-field TNS reactor concepts and the plasma engineering innovations discussed should be applicable to other designs of tokamak reactors; some of the suggested innovations will be tested in upcoming experiments.

27638 (PPPL-EPRI—7) **Classical diffusion in the presence of an X point.** Auerbach, S.P.; Boozer, A.M. (Princeton Univ., N.J. (USA). Plasma Physics Lab.). Jan 1978. Contract EY-76-C-02-3073. 48p. Dep. NTIS, PC A03/MF A01.

Classical plasma diffusion is studied in a two-dimensional system with an X point, the third dimension (the Z axis) being a symmetry direction. Several exact results are presented which give a good qualitative understanding of the diffusive flow in such a system. A soluble model which illustrates these results is also presented. These results may be summarized as follows: (a) The pressure gradient dP/d Psi (Psi is the poloidal flux) does not vanish on the separatrix; i.e., the diffusion coefficient D(Psi) is finite there. (b) Neglecting viscous or inertial effects, the poloidal flow follows lines of constant Hamada angle (defined in the text). This has the consequence that (i) all flow across the separatrix is channelled through the X point, and (ii) the flow velocity along the separatrix is formally infinite. Including viscous or inertial effects would, of course, remove this singularity while modifying the flow only in a small boundary layer region near the separatrix.

27639 (TRITA-PFU—77-02) **Power loss problems in EXTRAP coil systems.** Lehnert, B. (Tekniska Hoegskolan, Stockholm (Sweden). Institutionen foer Plasmafysik med Fusionsforskning). Feb 1977. 16p. Dep. NTIS (US Sales Only), PC A02/MF A01.

The Ohmic power loss in the coils of external ring traps is minimized with respect to the thermonuclear power production. In the case of the DT-reaction this leads to dimensions and power densities being relevant to full-scale reactors. Not only superconducting or refrigerated coil windings can thus be used, but also hot-coil systems which are operated at several hundred degrees centrigrade and form part of a steam cycle and power extraction system. For hot coils the problems of void formation and tritium regeneration have to be further examined. The high beta value leads to moderately large coil stresses. Finally, replacement and repair become simplified by the present coil geometry.

27640 (UWFDM—225) **Toroidal field magnet system utilizing normal metal trimming coils.** Michaelson, P.F.; Hong, S.O.; Young, W.C.; Sviatoslavsky, I.N.; Conn, R.W. (Wisconsin Univ., Madison (USA). Dept. of Nuclear Engineering). Oct 1977. Contract EY-76-C-02-2272. 8p. (CONF-771029—205). Dep. NTIS, PC A02/MF A01.

From 7. symposium on fusion research project; Knoxville, TN, USA (25 Oct 1977).

A conceptual design of a tokamak toroidal field (TF) magnet system with trimming coils to reduce field ripple throughout the plasma region is presented. The number and size of superconducting TF coils is reduced from conventional designs to provide more access for maintenance, blanket cooling, vacuum pumping and plasma heating schemes and to improve the operating economics. The resulting large toroidal field ripple is trimmed with normal copper coils located close to the plasma. Saddle shaped and ring shaped trimming coils are described. In addition to its primary function of trimming, a ring shaped normal coil also can be used to supply a fair amount of magnetic field strength to augment the maximum fields available from the superconducting coils. The cooling scheme, material selection, number, size, shape and placement of the superconducting coils and the trimming coils are discussed.

27641 (WFPS-TME—045) **Structural analysis methods and design solutions for OHMIC heating solenoids.** Smith, R.A. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Fusion Power Systems Dept.). Sep 1977. Contract W-7405-ENG-26. 19p. NTIS, MF A01. Portions of document are illegible.

Design equations with solutions are derived for the ohmic heating coil solenoid unique to a tokamak fusion device. The solutions are provided to perform a detailed structural analysis of every conducting turn in the radial build of the solenoid. The derivations follow from the theory of elasticity for a body possessing cylindrical anisotropy where the material properties are different in the radial and tangential directions. Distinction is made to provide separate models for the region of the solenoid: (a) where turn-to-turn radial contact is maintained with radial compression or with a bond tensile strength in regions of radial tension, and (b) where there is turn-to-turn radial separation due to the absence or the loss of bonding in locations of would-be radial tension.

27642 (WFPS-TME—056) **Trade study analysis for TNS tokamaks.** Chapin, D.L.; Garber, H.J.; Sink, D.A.; Gibson, G. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Fusion Power Systems Dept.). 30 Sep 1977. Contract W-7405-ENG-26. 22p. (CONF-771029—208). Dep. NTIS, PC A02/MF A01.

From 7. symposium on fusion research project; Knoxville, TN, USA (25 Oct 1977).

A series of parametric trade studies was performed to consistently evaluate the relative costs and performance parameters of D-T burning tokamaks over a range of plasma sizes and toroidal field (TF) coil technologies. Four different types of TF coil technologies were investigated: water-cooled copper coils, superconducting NbTi and Nb_3Sn coils, and a "hybrid" coil arrangement consisting of a normal conducting Cu coil nested within a superconducting NbTi coil. Results of the analysis indicate for TNS operation, for example, that for a given plasma beta at ignition, the Cu TF coil devices are least expensive, followed by the Nb_3Sn, NbTi, and NbTi/Cu options. Other conclusions and trends resulting from the study are presented and analyzed.

27643 (WFPS-TME—063) **Lateral support structure for constant tension D-shaped coils in tokamak fusion devices.** Fernandes, R. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Fusion Power Systems Dept.). 30 Sep 1977. Contract W-7405-ENG-26. 17p. (CONF-771029—201). Dep. NTIS, PC A02/MF A01.

From 7. symposium on fusion research project; Knoxville, TN, USA (25 Oct 1977).

Structural analyses were performed to optimize the geometry of the lateral support structure required to withstand the vertical field loading on the toroidal field (TF) coils in a tokamak fusion device. The loading results in lateral forces and overturning moments on each TF coil and produces slope distortions of the coil which tend to perturb the magnetic field. The optimization study was performed on constant tension D-shaped superconducting TF coils, similar to those that will be used in the Large Coil Project and The Next Step programs, and indicated that the most effective region for the lateral support structure is the space currently intended for the neutral beam window near the horizontal midplane. Lateral supports which did not occupy this space resulted in coil slope distortions in excess of ten milliradians while those that did yielded distortions of about one milliradian. An examination of the reactive force distribution on the lateral support structure indicates that a combination of radial and circumferential shear panels would be appropriate since it would provide space for the neutral beam window at an angle to the horizontal midplane, and, additionally, limit coil slope distortions.

27644 **Simulation of large magnetic islands: A possible mechanism for a major tokamak disruption.** White, R.B.; Monticello, D.A.; Rosenbluth, M.N. (Plasma Physics Laboratory, Princeton University, Princeton, New Jersey 08540). *Phys. Rev. Lett.;* **39**: No. 25, 1618-1621(19 Dec 1977).

It is known that an internal tokamak disruption leads to a current profile which is flattened inside the surface when the safety factor equals unity. It is shown that such a profile can lead to $m = 2$ magnetic islands which grow to fill a substantial part of the tokamak cross section in a time consistent with the observation of a major disruption.

27645 (LA-tr—78-10) **Selection of the superconducting current-carrying element for the "T-10M" installation.** Glukhikh, V.A.; Kostenko, A.I.; Monoszon, N.A.; Trokhachov, G.V.; Horn, E.A. (Nauchno-Issledovatel'skij Inst. Ehlektrofizicheskoj Apparatury, Leningrad (USSR)). 1977. Translation by M.D. Machalek of NIIEFA-B—0322. 20p. Dep. NTIS, PC A02/MF A01.

The basic principles for selection of the conductor for the "T-10M" installation are discussed. Various possible methods of circulating and immersion cooling of the conductor are presented.

POWER SUPPLIES, ENERGY STORAGE

27646 (EUR—5602, pp 741-746) **JET power supply comprehensive system.** Bertolini, E.; Ciscato, D.; Coccorese, E.; Hicks, J.B.; Selin, K.I. (UKAEA Research Group, Abingdon. Culham Lab.). 1976.

From 9. symposium on fusion technology; Garmisch-Partenkirchen, F.R. Germany (14 Jun 1976).

In Proceedings of the 9. Symposium on fusion technology.

The Joint European Torus (JET) Power Supply pulses system has to provide power and energy to four main loads; toroidal field coils (up to 380MW, 5500MJ), poloidal field coils (up to 300MW, 1200MJ), poloidal field control amplifiers (+50, -30MW, 500MJ), additional heating (>=25MW, 250MJ). The power supply scheme designed as a result of a compromise between JET requirements, site H.V. line characteristics and equipment manufacturing experience in industry, consists of a combination of constant frequen-

cy units (transformers + controlled convertor (TCC)), directly supplied by the mains at 400kV during the pulse and variable frequency units (flywheel generator convertor (FGC)), isolated from the electric system during the pulse.

27647 (EUR—5602, pp 765-769) **Dynamic behavior of a resistive transfer circuit with a superconducting switch.** Ulbricht, A. (Kernforschungszentrum Karlsruhe (Germany, F.R.). Inst. fuer Experimentelle Kernphysik). 1976.

From 9. symposium on fusion technology; Garmisch-Partenkirchen, F.R. Germany (14 Jun 1976).

In Proceedings of the 9. Symposium on fusion technology.

For development of components of the pulsed coils for fusion reactors a resistive transfer circuit with a superconducting switch was tested up to 12kV and 6MW pulse power. Investigations of the transfer process led to results which can be explained by using an equivalent circuit. In this circuit the transition process to the normal state of the conductor was taken into account as well as the self-inductance of the switch. The influences of self-capacitance, the capacitane to earth and the trigger capacitors were investigated.

27648 (GA-A—14614(Vol.11)) **GAC—ANL TNS scoping studies. Status report for FY-77, October 1, 1976—September 30, 1977. Volume XI. TNS doublet tokamak ohmic-heating power supply study. LA-7053-MS.** (Los Alamos Scientific Lab., N.Mex. (USA)). Dec 1977. Contract EY-76-C-03-0167-038;W-7405-ENG-36. 122p. Dep. NTIS, PC A06/MF A01.

The primary emphasis has been to examine the feasibility of a homopolar machine as an energy transfer and storage element in the circuit of the TNS doublet, to address the related switching problems, and to consider the nature of the plasma showdown at the end of the burn cycle. Parameters supplied for the studies set the peak current and voltage at about 3 MA and 1 kV, respectively, with a 2-s start-up for the ohmic-heating phase. The stored energy in the ohmic-heating coils was estimated to be 500 MJ and the total flux change to be 34 Vs. Of this amount, 20 Vs supplies the plasma inductive loading and 8 Vs the plasma resistive losses. The remainder powers the burn phase. The six parts of the study analyze the circuit, present a minimal conceptual engineering analysis of an air core superconducting field coil excited homopolar machine, provide a comparative design of an iron dominated homopolar machine, address the circuit or current interruption problem as well as the connecting bus, and discuss the plasma shutdown. Approximate costs are developed for both homopolar machines. In particular, a variable capacitance homopolar machine with superconducting field coils has been considered.

27649 (JAERI-M—6803) **Design study of electrical power supply system for tokamak fusion power reactor.** (Japan Atomic Energy Research Inst., Tokyo). Jan 1977. 183p. (In Japanese). Dep. NTIS (US Sales Only), PC A09/MF A01.

Design study of the electrical power supply system for a 2000MWt Tokamak-type fusion reactor has been carried out. The purposes are to reveal and study problems in the system, leading to a plan of the research and development. Performed were study of the electrical power supply system and design of superconducting inductive energy storages and power switches. In study of the system, specification and capability of various power supplies for the fusion power reactor and design of the total system with its components were investigated. For the superconducting inductive energy storages, material choice, design calculation, and structural design were conducted, giving the size, weight and performance. For thyristor switches, circuit design in the parallel / series connection of element valves and cooling design were studied, providing the size and weight.

27650 (LA-tr—78-13) **Results of research into superconducting switches with high specific switching capacity.** Glukhikh, V.A.; Kostenko, A.I.; Monoszon, N.A.; Tishchenko, V.A.; Trokhachov, G.V. 1977. Translation by M.D. Machalek of USSR paper. (CONF-7706118—1). 9p. Dep. NTIS, PC A02/MF A01.

From Conference on engineering problems of thermonuclear reactors; Leningrad, USSR (28 Jun 1977).

Portions of document are illegible.

An attempt was made to clarify the reasons for instability and degradation of current and also for a determination of possible means of increasing the current-carrying capacity of superconducting switches. Several experimental switches were prepared with various widths of foils and various methods of holding the switches together. Two had mechanical bonding while the remainder were impregnated with epoxy resin. (MHR)

27651 (LA-tr—78-12) **Application of a two superconducting ellipsoidal coil system without external magnetic field as an inductive energy storage (Part 1).** Egorov, S.A.; Kostenko, A.I. 1977. Translation by M.D. Machalek of NIIEFA-B—0310. 21p. Dep. NTIS, PC A02/MF A01.

The size and weight of an inductive energy storage system are estimated and compared with toroidal magnetic systems using two series-connected, opposed-field, confocal, ellipsoidal, superconducting coils without external magnetic field. (MHR)

COOLING SYSTEMS

REFER ALSO TO CITATION(S) 27617

HEATING AND FUELING SYSTEMS

27652 (CEA-CONF—3864) **Source of low energy neutrals (1 to 4kV) for the production of negative ions.** Geller, R.; Jacquot, C.; Ludwig, P.; Sermet, P. (Association Euratom-CEA, Centre d'Etudes Nucleaires de Grenoble, 38 (France). Groupe de Recherches sur la Fusion Controlee; CEA Centre d'Etudes Nucleaires de Grenoble, 38 (France). Service d'Ionique Generale). 1976. 7p. (In French). (CONF-761232—8). Dep. NTIS (US Sales Only), PC A02/MF A01.

From National congress on plasma physics; Paris, France (6 Dec 1976).

An ECR (Electron Cyclotron Resonance) ion source, based on a fourwaveguide system and furnishing 2A equivalent of D^0 is described.

27653 (CEA-CONF—3865) **Sources for high frequency heating. Performance and limitations.** Le Gardeur, R. (Association Euratom-CEA, Centre d'Etudes Nucleaires de Grenoble, 38 (France). Groupe de Recherches sur la Fusion Controlee; CEA Centre d'Etudes Nucleaires de Grenoble, 38 (France). Service d'Ionique Generale). 1976. 18p. (In French). (CONF-761232—9). Dep. NTIS (US Sales Only), PC A02/MF A01.

From National congress on plasma physics; Paris, France (6 Dec 1976).

The various problems encountered in high frequency heating of plasmas can be decomposed into three spheres of action: theoretical development, antenna designing, and utilization of power sources. By classifying heating into three spectral domains, present and future needs are enumerated. Several specific antenna designs are treated. High frequency power sources are reviewed. The actual development of the gyratron is discussed in view of future needs in very high frequency heating of plasmas.

27654 (EUR—5602, pp 857-861) **Water cooled extraction grids.** Becherer, R. (Association Euratom-CEA, Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France). Groupe de Recherches sur la Fusion Controlee; CEA Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France). Dept. de Physique du Plasma et de la Fusion Controlee). 1976.

From 9. symposium on fusion technology; Garmisch-Partenkirchen, F.R. Germany (14 Jun 1976).

In Proceedings of the 9. Symposium on fusion technology.

The extraction of long pulse or DC-beams at high power level needs extraction grids which are cooled in a very intense and direct way. Between various possible cooling systems, a special grid system has been chosen and tested, in which the grids are water-cooled by channels, drilled through the grids. The correct operation of these grids under DC-condition depends critically upon the focalization of the ion-beam. Accidental thermal overloads can be absorbed by the thermal capacity of the grids and do not damage the system. Temperature measurements on the surface and in the cooling water of the grids are reported and the thermal resistance, depending upon the velocity of the water flow in the cooling-channels is calculated and compared with the measurements. Estimated limits of DC operation is given.

27655 (EUR—5602, pp 393-398) **Plasma studies of a catalyzed-D noncircular tokamak.** Southworth, F.H.; Miley, G.H. (Illinois Univ., Urbana (USA)). 1976.

From 9. symposium on fusion technology; Garmisch-Partenkirchen, F.R. Germany (14 Jun 1976).

In Proceedings of the 9. Symposium on fusion technology.

The use of the 'catalyzed deuterium' fuel cycle in a Tokamak power reactor is compared to a D-T cycle in the present work. Large reactor sizes and magnetic fields are necessary for catalyzed deuterium but several advantages are obtained. These include the possible use of direct conversion and a simplified blanket design because tritium breeding is unnecessary and radiation damage is reduced. With large reactor powers (about 12GW), ignited operation of the 'catalyzed deuterium' Tokamak appears to be possible with some safety margin.

27656 (IPPJ-DT—49) **Ion extraction from high electron temperature plasma and mass analysis.** Matsumoto, A.; Okuno, K.; Aihara, S.; Otani, S.; Honzawa, T. (Nagoya Univ. (Japan). Inst. of Plasma Physics). 1976. 23p. (In Japanese). Dep. NTIS (US Sales Only), PC A02/MF A01.

The preliminary experiment concerning a multivalent ion source was performed with a high electron temperature plasma device of Nagoya University. The high electron temperature plasma was produced by the electron cyclotron resonance (ECR) in the mirror field. The microwave discharge of 2.45 GHz was operated

continuously or in pulse mode. The effect of the magnetic field on the identification of ions was reduced with a quadrupole mass filter and a magnetic shield. By observing the mass spectra of the residual gas in the apparatus, it can be said that the magnetic shield worked very well. The mass analysis of the extracted ion beam was also made. Existence of Ar^{3+} and Ar^{4+} was recognized. The spectra of H^+, N^+, O^+, C^{2+}, O^{2+} and N^{2+} were observed. The kinetic energy of ions was measured with a set of three grids on which electric field was applied. It is considered that the observed energy distribution is due to the voltage distribution of the places of the birth of ions. The mass spectra of ions are very sensitive to the condition of discharge and the lens action. The relation between the absorption coefficient of microwave power and the strength of mirror field was investigated. As a concluding remark, it is said that the present quadrupole mass filter with a magnetic shield works well, and it is a good tool for the analysis of multivalent ions.

27657 (IPPJ-DT—51) **Lithium ion source of thermionic emission type.** Kadota, K.; Kawasumi, Y.; Fujita, J.; Yamazaki, H.; Kobayashi, N. (Nagoya Univ. (Japan). Inst. of Plasma Physics). 1976. 11p. (In Japanese). Dep. NTIS (US Sales Only), PC A02/MF A01.

In this paper, the ion emission characteristics of a lithium ion source and its ion beam are explained. The ion source was made as a beam source for the neutral particle beam probe method. The ion emitter (beta-eucryptite) was coated on a platinum plate, and heated by a tungsten heater. The emitted ion current was measured as the functions of anode and grid voltages. Following the results of this measurement, further experiments were carried out at the grid voltage of 0 V for the anode voltage less than 100V and at the grid voltage between -10V and -40V for the anode voltage more than 200V. The relation between ion current and anode voltage was measured at various anode temperature. The current saturated above some anode voltage. The saturation current depends on the temperature. The results of measurement were not in agreement with those of the theoretical analysis. The life of the ion source was also measured. The experiment on the production of lithium ion beam was performed with this ion source. The beam profile was observed with a movable probe at the beam energy of 3 KeV. The full width at half maximum was 8mm, and the beam current measured by a Faraday cup was 100 μ A. The analysis of elements in the beam was made by a magnetic mass spectrometer. The ions included in the beam were mostly lithium ions, and the proportion of other elements ($^{23}Na^+$, $^{39}K^+$, and $^{41}K^+$) was about 0.5%.

27658 (LBL—6830) **Status of the LBL/LLL development program.** Berkner, K.H.; Cooper, W.S.; Ehlers, K.W.; Pyle, R.V.; Hooper, E.B. Jr. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Nov 1977. Contract W-7405-ENG-48. 6p. (CONF-771129—9). Dep. NTIS, PC A02/MF A01.

From Workshop on fusion fueling; Princeton, NJ, USA (1 Nov 1977).

The status and near-term goals of the LBL/LLL neutral-beam-development program are described. The emphasis is on the technology of systems based on the acceleration and neutralization of positive ions; this approach will be used in the near term, probably through 1985 at least. For more efficient injection, part of the plan is to develop a negative-ion approach suitable for 200- to 400-kV injectors on confinement experiments in the 1985 to 1990 period. However, the negative-ion based program is still very much in the research phase, and it is difficult to project how it will phase into fusion reactor fueling experiments.

27659 (UCID—17672) **Alternate approaches to D- beam production.** Osher, J.E. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 30 Nov 1977. Contract W-7405-ENG-48. 15p. Dep. NTIS, PC A02/MF A01.

An intense source of negative ions now appears essential to the efficient production of D^0 beams with energies approximately greater than 200 keV. The standard approaches now under active R and D include (1) double charge exchange of a low energy D^+ beam in Cs (or Na), or (2) direct extraction from a Dimov type source. Some preliminary ideas are described for (1) a surface plasma type Penning discharge source with large area multiple aperture direct extraction, (2) a volume type negative ion rich plasma source with similar direct extraction, and (3) an alternate form of low energy ion source for double charge exchange.

27660 (UCID—17692) **Analytical estimates for higher energy neutral beams in MFTF.** Shearer, J.W. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 20 Dec 1977. Contract W-7405-ENG-48. 14p. Dep. NTIS, PC A02/MF A01.

Some aspects of the injection of higher energy (80 to 480 keV) neutral beams into the MFTF plasma are briefly considered. The plasma is assumed to be in steady state with β/sub perpendicular/ = 0.5, and with edge stabilization of the DCLC instability. Nonadiabaticity, electron drag, and ion—ion scattering are considered, and results are presented for average ion energy, containment parameter eta tau, plasma density, neutral beam current, and absorption efficiency.

27661 **Improvements in or relating to fusion nuclear reactors.** Spalding, I.J. (to UKAEA). British Patent 1,482,526/A/. 10 Aug 1977. 3p.

A method of re-fuelling a fusion reactor is described that comprises subjecting a pellet of solid fuel, for example a mixture of D and T, to a pulse of laser energy of intensity such as to vaporise a portion of the pellet, for a duration such that the temperature distribution throughout the pellet remains non-uniform, and of such direction that the resultant forces acting on the pellet direct it into the reactor. The reactor is preferably of toroidal configuration (author).

27662 **Conditions for a boron fusion reactor in the MeV range.** Treglio, J.R. (Fusion Energy Corp., Princeton, N.J. (USA)). *Nucl. Instrum. Methods;* **144**: No. 1, 65-68(1 Jul 1977).

In a previous paper it was shown that the reaction $p+{}^{11}B \rightarrow 3\,{}^4He + 8.6$ MeV has potential as an energy source in the MeV energy range. In this paper, modifications are made on the original calculations. These include: a) self-consistent calculation of the boron and proton densities, b) electron leakage, c) reabsorption of synchrotron radiation, and d) electron-electron bremsstrahlung. The result is a reduction in ntau to approximately $3x10^{15}$s/cm^3 from $7.5x10^{15}$ (etasub(c2)=0.95) and a lowering of the minimum density requirement to about 10^{15}cm^{-3}. It is also found that a boron burn rate of 30% is a minimum for a successful p-^{11}B reactor.

27663 **Neutral beam injector research and development work in the USA.** Stewart, L.D.; Barber, G.C.; Dagenhart, W.K. (Oak Ridge National Lab., Tenn. (USA)) (and others). pp 293-299 of Plasma physics and controlled nuclear fusion research 1976. Proceedings of the 6. international conference held by the IAEA at Berchtesgaden, 6-13 October 1976. Vol. 3. Vienna; IAEA (1977).

From 6. international conference on plasma physics and controlled nuclear fusion research; Berchtesgaden, F.R. Germany (6 Oct 1976).

See CONF-761012—.

Neutral beam injection research and development at Brookhaven National Laboratory, Lawrence Berkeley and Livermore Laboratories, and Oak Ridge National Laboratory is described. The ORNL Neutral Beam Development Program is concentrated on the development and application of tokamak neutral beam injection systems. Tokamak neutral beam development is being carried out for Ormak, PLT, Ormak-Upgrade, PDX and TFTR. Applications have been made to Ormak and are being made to PLT. Basic research in support of the development programme includes work in the areas of plasma sources, ion extraction and beam optics, cryopumping, beam stops and megawatt electrical power systems. The LBL/LLL Neutral Beam Development Program can be divided into two areas: 1) Development based on positive-ion acceleration and neutralization, primarily for near-term applications on the 2X, BB, MX, and TFTR confinement experiments, and 2) a higher-efficiency-injector programme based on acceleration and neutralization of negative ions, which may be required for fusion reactors and reactor-like experiments. In addition, there is related work (not described here) on negative-ion production and on direct energy recovery. The objective of the BNL Neutral Beam Program is to develop a 150 keV multiampere (equivalent) neutral injector with essential support systems based on long-pulse, multiampere sources of negative hydrogen and deuterium ions, close-coupled acceleration to the required energy and on neutralization of high-energy negative ions in a gas or plasma jet. High-speed cryogenic and molecular sieve pumps are being developed as part of the programme.

27664 **Solid hydrogen pellet injection into the ORMAK tokamak.** Foster, C.A.; Colchin, R.J.; Milora, S.L. (Oak Ridge National Lab., Tenn. (USA)); Kim, K.; Turnbull, R.J. (Illinois Univ., Urbana (USA). Dept. of Electrical Engineering). *Nucl. Fusion;* **17**: No. 5, 1067-1075(1977).

Solid hydrogen spheres were injected into the ORMAK tokamak as a test of pellet refuelling for tokamak fusion reactors. Pellets 70μm and 210μm in diameter were injected with speeds of 91m/s and 100m/s, respectively. Each of the 210-μm pellets added about 1% to the number of particles contained in the plasma. Excited neutrals, ablated from these hydrogen spheres, emitted light, which was monitored either by a photomultiplier or by a high-speed framing camera. From these light signals it was possible to measure pellet lifetimes, ablation rates, and the spatial distribution of hydrogen atoms in the ablation clouds. The average measured lifetime of the 70-μm pellets was 422μs, and the 210-μ spheres lasted 880μs under bombardment by the plasma. These lifetimes and measured ablation rates are in good agreement with a theoretical model which takes into account shielding of plasma electrons by hydrogen atoms ablated from spherical hydrogen ice.

27665 **Cross-field injection, propagation, and energy deposition of intense ion beams with application to tokamak plasma heating.** Ott, E.; Manheimer, W.M. (Naval Research Lab., Washington, D.C. (USA)). *Nucl. Fusion;* **17**: No. 5, 1057-1065(1977).

The recent availability of intense, space-charge-neutralized, energetic ion beams has led the authors to explore the possibility of using them for heating tokamak plasmas. The following key problems for this application are investigated: (i) beam injection perpendicular to B vector, (ii) beam propagation across B vector in vacuum, and (iii) cross-field beam propagation and energy deposition in plasma. It appears possible that, for proper values of the beam energy, radius and current, an intense ion beam can penetrate to the interior of a tokamak plasma and deposit its energy there.

POWER CONVERSION SYSTEMS

27666 **Experimental and computational results on direct energy conversion for mirror fusion reactors.** Barr, W.L.; Moir, R.W.; Kinney, J.D. (California Univ., Livermore (USA). Lawrence Livermore Lab.). *Nucl. Fusion;* **17**: No. 5, 1015-1022(1977).

This paper presents the results of measurements of space-charge effects on the efficiency of a direct converter. The device consists of a 22-stage, electrostatic periodic-focusing, direct energy converter, a magnetic expander, and a hydrogen plasma source. At low beam density, the measured average efficiency is 86.5+-1.5% as compared with the predicted one of 88.6+-1.5%. At higher beam density, the measured efficiency decreases with increasing space charge in agreement with predictions. The effect of space charge is increased if the ion energy is decreased or if the energy distribution is made narrower. Design criteria for scaling the recovery system for a reactor show that this direct converter is probably economical only if the mean ion energy is greater than 500 keV. - In addition to presenting the space-charge measurements, this paper is intended to serve as a final summary of the authors' work on this type of direct converter.

INERTIAL CONFINEMENT TECHNOLOGY

REFER ALSO TO CITATION(S) 26718

27667 (CEA-CONF—3886) **Fluid dynamic stability studies of laser imploded spherical shells.** Sitt, B.; Wilke, N.; Barbry, H. (CEA Centre d'Etudes de Limeil, 94 - Villeneuve-Saint-Georges (France)). 1976. 25p. (CONF-761108—35). Dep. NTIS (US Sales Only), PC A02/MF A01.

From Plasma physics meeting of the American Physical Society; San Francisco, CA, USA (15 Nov 1976).

Major simplifications are obtained by using a purely Lagrangian analytical model in the study of small perturbations of a spherical shell implosion. Two problems have been numerically investigated by combining such a model with an expansion of first-order perturbations into spherical harmonic modes. The assumption that a representative pressure time law is applied to the shell outer boundary being made, the problem of the instability of the inner boundary after its crossing by the outwardly propagating, reflected shock, i.e. during the decelerated phase of the implosion is treated in the perfect fluid approximation. The problem of the instability of the shock front and ablation front, during the accelerated phase, when the implosion is driven by absorption of a laser flux, is then treated in the frame of a non necessarily perfect two-temperature fluid model. In both cases, initial perturbations correspond to defects in the shell sphericity. Some results are presented and discussed for lower order harmonic modes.

27668 (Juel—1399) **Calculations of the laserlight-transmission in laser-fusion-reactors at various densities and density-profiles.** Duedder, H.D. (Kernforschungsanlage Juelich G.m.b.H. (Germany, F.R.). Inst. fuer Plasmaphysik; Association Euratom-KFA, Juelich (Germany, F.R.); Technische Hochschule Aachen (Germany, F.R.)). Mar 1977. 58p. (In German). Dep. NTIS (US Sales Only), PC A04/MF A01.

Thesis.

In this thesis the laserlight-propagation in a Laser-Fusionreactor at various densities and density-profiles shall be examined in order to determine the optimum density under various conditions. For this purpose the computer code RAMSES has been written, which simulates in two dimensions the photon-motion through a gas or plasma. The method of simulation is essentially a PIC-(particle-in-cell) model. The programme takes into account refraction-effects and variations of the group velocity caused by the local electron density, which may be supplied either explicitly or calculated from the ionisation rates. A parameter study has been carried out in order to calculate the laser-transmission-rates for different density profiles and under various conditions. With the restraining condition of a transmission of 95% of the original pulse energy into the target region the optimum density in each case is determined. Finally - as an example for application - these optimum densitites lead to restrictions on the wall-temperature of the reactor-vessel.

27669 (NRL-MR—3669) **High energy ion expansion in laser-plasma interactions.** Decoste, R.; Ripin, B.H. (Naval Research Lab., Washington, D.C. (USA)). Dec 1977. Contract ES-77-A-01-6021. 16p. Dep. NTIS, PC A02/MF A01.

Measurements of energetic ion distributions produced from CD_2 and CH_2 targets are compared with a numerical model. The model describes the ambipolar expansion of hot electrons and two relatively cold ion species from a pressure gradient. For CD_2 the plasma expansion is adequately represented by a single ion species, whereas for CH_2 two ion fluids are required to account for the energy and the relative behavior of the high energy ion species.

27670 (SAND—77-1587C) **High resolution time resolvable flash x-radiography system.** Chang, J.; Kuswa, G.W.; Mendel, C.W. (Sandia Labs., Albuquerque, N.Mex. (USA)). 1978. Contract EY-76-C-04-0789. 5p. (CONF-780202—14). Dep. NTIS, PC A02/MF A01.

From Topical meeting on inertial confinement fusion; San Diego, CA, USA (7 Feb 1978).

A 600 kV, approximately less than 100 μm diameter, and 3 ns flash X-ray source has been developed. This source has been coupled to a duo-microchanneltron X-ray camera to form a flash X-radiography system capable of 3 ns temporal resolution and 100 μm spatial resolution.

27671 (UCID—17703) **SHIVA Nd: glass disk-amplifier-assembly facility and special purpose fixtures.** Jones, W.A.; Patton, H.G.; Stowers, I.F.; Wentworth, D.E. (California Univ., Livermore (USA). Lawrence Livermore Lab.). Sep 1977. Contract W-7405-ENG-48. 9p. Dep. NTIS, PC A02/MF A01.

The facility built to assemble and maintain the laser amplifiers in the SHIVA Laser System is described. The facility is a Class-100 clean room which includes a high pressure solvent spray box, optical inspection equipment, and several unique amplifier-assembly fixtures.

27672 (UCRL—13677-3) **Research on the wetted first wall concept for future laser fusion reactors. Final report No. 2, February 1, 1976—August 31, 1977.** Hoffman, M.A. (California Univ., Davis (USA). Dept. of Mechanical Engineering). Sep 1977. Contract W-7405-ENG-48. 62p. Dep. NTIS, PC A04/MF A01.

The possible application of thin, falling liquid lithium films to protect the inner walls of future laser fusion reactors is discussed. It has been proposed that the relatively smooth initial region of a falling liquid film can provide the nearly uniform liquid thickness on the order of a few hundred micrometers required to prevent radiation and plasma ions from the fusion micro-explosion from seriously damaging the solid first wall. In order to extend the existing results on liquid films to the higher surface tension numbers characteristic of alkali metals, experiments using hot water on a vertical plate were run primarily in the wavy laminar flow regime. Results show that very low minimum flow rates can fully wet the surface provided that the surface is carefully cleaned and preconditioned. It is also shown that both the wave inception distance and the equilibrium wave amplitude decrease as the surface tension number increases for a given flow Reynolds number. Based on these results, the scaling laws for the minimum wetting rate, the wave inception distance and the saturated or equilibrium wave amplitude can now be extended up to surface tension numbers of about 10,000.

27673 (UCRL—52000-77-8) **Energy and technology review.** Shay, H.D.; Crawford, R.B.; Staehle, J.T. (California Univ., Livermore (USA). Lawrence Livermore Lab.). Aug 1977. Contract W-7405-ENG-48. 51p. Dep. NTIS, PC A04/MF A01.

Separate abstracts were prepared for each of the six included sections. (MOW)

27674 (UCRL—52000-77-8, pp 1-4) **Laser fusion program overview.** Emmett, J.L. Aug 1977.

In Energy and technology review.

This program is structured to proceed through a series of well defined fusion milestones to proof of the scientific feasibility, of laser fusion with the Shiva Nova system. Concurrently, those key technical areas, such as advanced lasers, which are required to progress beyond proof of feasibility, are being studied. We have identified and quantified the opportunities and key technical issues in military applications, such as weapons effects simulations, and in civilian applications, such as central-station electric power production. We summarize the current status and future plans for the laser fusion program at LLL, emphasizing the civilian applications of laser fusion.

27675 (UCRL—52000-77-8, pp 5-12) **Laser fusion targets.** Nuckolls, J.H. Aug 1977.

In Energy and technology review.

Fusion-power reactors of the future will require both high-power lasers and high-performance targets. Our target program is developing the targets. LASNEX, our highly sophisticated computer program, has been used quite successfully in designing targets and in predicting experimental results. We have developed four classes of target designs that will move us successively closer to reactor-level yields.

27676 (UCRL—52000-77-8, pp 13-22) **Solid-state laser program.** Holzrichter, J.F. Aug 1977.

In Energy and technology review.

The basic objective of the solid-state laser program at LLL is to provide the high-power pulsed lasers needed to study laser fusion target implosion. We estimate that we will need laser pulses with peak power greater than 200 TW to perform a scientific feasibility laser fusion experiment. This corresponds to a 200-kJ pulse delivered in 1 ns. We have developed a laser technology, based on glass doped with neodymium ions, to accomplish this goal. We have demonstrated 4.6-TW operation with the Argus laser system, and we will soon demonstrate over-20-TW operation with the Shiva laser. We are designing the Nova laser for 200- to 300-TW operation by 1984.

27677 (UCRL—52000-77-8, pp 23-29) **Diagnosis of laser fusion targets.** Ahlstrom, H.G. Aug 1977.

In Energy and technology review.

These experiments on exploding-pusher targets have established several key facts about laser fusion and serve as benchmark tests for the predictive powers of the design codes. We used several experimental techniques to determine these characteristics of target implosions: the symmetry of laser heating and compression, evidence of thermonuclear burn, implosion dynamics, and fusion yield.

27678 (UCRL—52000-77-8, pp 30-37) **Advanced lasers for power production.** Krupke, W.F. Aug 1977.

In Energy and technology review.

The large neodymium-glass lasers being built at LLL appear more than adequate to demonstrate the scientific feasibility of laser fusion reactors, but they will be unable to provide the high pulse-repetition rate required for efficient power production. While investigating ways to extend these laser systems to high-repetition-rate operation, we are also studying other potentially superior laser systems: gas lasers based on rare-earth molecular vapors or on photodissociation of simple polyatomic molecules containing oxygen, sulfur, or selenium; a solid-state laser of glass or calcium fluoride doped with trivalent thulium; a pulse compressor for long-pulse noble-gas--halogen excimer lasers. It appears possible to scale up any of these systems to high energies. Experiments now under way should permit us to select the system best suited for development into a practical power-producing laser.

27679 (UCRL—52000-77-8, pp 38-43) **Applications of laser fusion.** Maniscalco, J.A. Aug 1977.

In Energy and technology review.

We have studied several commercial applications of laser fusion to point the way toward its development for use in energy production. This article discusses three such applications: electric power production, synthetic fuel production, and fissile fuel breeding. We focus on a fluid-wall reactor concept for an electric power plant that takes advantage of the unique features of laser fusion.

27680 (UCRL—79364) **Rare earth vapor laser studies.** Krupke, W.F.; Jacobs, R.R. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 13 Sep 1977. Contract W-7405-ENG-48. 8p. (CONF-771039—9). Dep. NTIS, PC A02/MF A01.

From 13. rare earth research conference; Olgebay Park, WV, USA (16 Oct 1977).

The fluorescence decay rates of vapor phase neodymium aluminum chloride complex (Nd-Al-Cl) and neodymium-thd-chelate have been measured as functions of temperature, partial pressure and optical excitation intensity. Fluorescence quenching due to both ground and excited state collisions was observed in Nd-Al-Cl vapor. In constrast, quenching in the Nd-thd vapor was found to be dominated by multiquantum excitation of molecular vibrations. The fluorescence kinetics of Tb-Al-Cl vapor have also been examined under conditions of intense excitation of terbium 5d levels by a KrF laser source. Both prompt and delayed fluorescence of the $4f^8(^5D_4)$ metastable level were observed together with evidence of excited-state collisional quenching. In laser amplifier experiments, a transient (greater than or equal to 10 μsec) population inversion was produced in Nd-Al-Cl vapor with a small signal gain coefficient greater than or equal to 0.25%/cm and a stored energy density approximately equal to 35 J/liter. Available data for the rare earth vapors are related to scaling requirements of large amplifiers for laser fusion application.

27681 (UCRL—79653(Rev.1)) **Laser driven fusion fission hybrids.** Hansen, L.F.; Maniscalco, J.A. (California Univ., Livermore (USA). Lawrence Livermore Lab.). Nov 1977. Contract W-7405-ENG-48. 38p. (CONF-771102—15). Dep. NTIS, PC A03/MF A01.

From 20. annual AICHE meeting; New York, NY, USA (13 Nov 1977).

The role of the fusion-fission hybrid reactor (FFHR) as a fissile fuel and/or power producer is discussed. As long range options to supply the world energy needs, hybrid-fueled thermal-burner reactors are compared to liquid metal fast breeder reactors (LMFBR). A discussion of different fuel cycles (thorium, depleted uranium, and spent fuel) is presented in order to compare the energy multiplication, the production of fissile fuel, the laser efficiency and pellet gain requirements of the hybrid reactor. Lawrence Livermore Laboratory (LLL) has collaborated with Bechtel Corporation and with Westinghouse in two engineering design studies of laser fusion driven hybrid power plants. The hybrid designs which have resulted from these two studies are briefly described and analyzed by considering operational parameters, such as energy multiplication, power density, burn-up and plutonium production as a function time.

27682 (UCRL—80162) **Plasma polymerization coating of D-T filled glass shells for laser fusion targets.** Johnson, W.L.; Hatcher, C.W.; Hendricks, C.D.; Letts, S.A.; Lorensen, L.E. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 30 Sep 1977. Contract W-7405-ENG-48. 6p. (CONF-780202—15). Dep. NTIS, PC A02/MF A01.

From Topical meeting on inertial confinement fusion; San Diego, CA, USA (7 Feb 1978).

Three plasma sources are described which activate monomers of perfluoro-2-butene or tetrafluoroethylene to produce coatings 10 to 20 μm thick with surfaces finishes <0.1 μm. Electrical and chemical controls of the polymerization processes are shown to improve the surface finish.

27683 **Transport of long—mean-free-path electrons in laser-fusion plasmas.** Albritton, J.R.; Bernstein, I.B.; Valeo, E.J.; Williams, E.A. (Laboratory for Laser Energetics, University of Rochester, Rochester, New York 14623). *Phys. Rev. Lett.;* **39**: No. 24, 1536-1540(12 Dec 1977).

The Fokker-Planck kinetic equation for suprathermal electrons which are confined in a spherical plasma by the sheath potential and collide with colder denser electrons and ions is investigated. In the region where the collisional mean free path, λ, is longer than the spatial scale length, L, the kinetic equation is reduced by averaging it along an orbit between reflections by the sheath. The electrons are seen to diffuse in impact parameter relative to the plasma core while slowing down in velocity. The resulting heat flow scales as (L/λ) n/sub s t h/mv/sub s t h/^{3}.

27684 **Space charge limited current flow between concentric spheres at potentials up to 15 MV.** Wheeler, C.B. (Imperial Coll. of Science and Technology, London (UK)). *J. Plasma Phys.;* **10**: No. 9, 1645-1649(Sep 1977).

Poisson's equation in spherical symmetry is solved numerically with the assumptions of zero field and zero electron energy at the cathode surface. The computed current is expressed in terms of an analytic solution obtained for the extreme relativistic case. Internal and external anode configurations are treated, with ratio of electrode radii extending to 10 000 and potential difference up to 15 MV. Application of this analysis to the achievement of controlled fusion through pellet compression by charged particles is considered.

27685 **Summary of inertial confinement.** Krokhin, O.N. (AN SSSR, Moscow. Fizicheskij Inst.). pp 563-569 of Plasma physics and controlled nuclear fusion research 1976. Proceedings of the 6. international conference held by the IAEA at Berchtesgaden, 6-13 October 1976. Vol. 3. Vienna; IAEA (1977).

From 6. international conference on plasma physics and controlled nuclear fusion research; Berchtesgaden, F.R. Germany (6 Oct 1976).

See CONF-761012—.

27686 **Non-linear interaction of intense CO_2 radiation with dense plasma.** Grek, B.; Pepin, H.; Johnston, T.W.; Leboeuf, J.N. (Quebec Univ., Varennes (Canada). Energy Research Centre); Baldis, H.A. (National Research Council of Canada, Ottawa, Ontario. Div. of Physics). *Nucl. Fusion;* **17**: No. 6, 1165-1185(1977).

Experimental results of the interaction of short (1.5ns) CO_2 laser pulses with solid targets at a flux reaching 10^{13}W/cm^2 are presented. An attempt is made to carry out a global series of measurements and interpret them in the light of currently available theory. The absorption, reflection, ion and X-ray emission (line and continuum) and in considerable detail the infra-red emission spectra of the plasma in the vicinity of the incident 10.6μm radiation as well as its harmonics were measured. From the emission spectra the existence of the parametric decay and the stimulated Brillouin backscatter instabilities was indentified. Furthermore, the energy and angular dependence of the reflected-light calorimetry in addition to the X-ray and ion emission results are found to be consistent with the hypothesis that the interaction of high power CO_2 lasers with plasmas is dominated by non-linear effects such as the parametric decay instability.

27687 **Ablation driven thermonuclear implosion targets of high efficiency.** Winterberg, F. (Nevada Univ., Reno (USA). Desert Research Inst.). *Atomkernenergie;* **30**: No. 2, 159-160(1977).

The short communication shows that 'star-shaped' shells of D-T targets require much lower laser, electron, or ion beam energies than spherical shells to initiate thermonuclear microexplosions.

27688 Power lasers for thermonuclear fusion. Basov, N.G.; Krokhin, O.N.; Sklizkov, G.V.; Fedotov, S.I. *Pr. Nauk. Uniw. Slask. Katowicach;* No. 12, 10-27(Dec 1976). (In Russian).

The use of a powerful laser radiation for thermonuclear synthesis is described. Radiation parameters are considered of power lasers and methods for forming laser pulses with limiting parameters. Using as an example a 216-beam laser unit "Delfin" based on neodymium lasers, principles are described of constructing power laser systems. The "Delfin" will make it possible to obtain an energy of 10 kJ per pulse of 1ns, the light power output will be 10^{13} W, and the radiation brightness, 10^{17} W/cm^{2}xsterad. Problems are presented of construction of a diagnostic complex of the unit. Prospects are pointed out for the development of laser thermonuclear units, not only on neodymium, but also on chemical, photodissociation, and CO_2 lasers.

27689 Investigation of compression of hollow microspheres irradiated by a laser. Basov, N.G.; Zakharenkov, Yu.A.; Zorev, N.N.; Kologrivov, A.A.; Krokhin, O.N.; Rupasov, A.A.; Sklizkov, G.V.; Shikanov, A.S. (AN SSSR, Moscow. Fizicheskij Inst.). *Zh. Eksp. Teor. Fiz.;* **71**: No. 5, p. 1788-1798(Nov 1976). (In Russian).

Results are presented of an investigation of the interaction between the radiation from the "Calmar" nine-channel laser assembly and hollow microspheres. The fraction of light energy absorbed by the plasma is determined by various methods. The effect of initial perturbations on the stability of compression of a hollow target is elucidated. A volume compression of approximately 200 is recorded for a homogeneous glass microsphere.

27690 Stationary model of the 'corona' of spherical laser targets. Afanas'ev, Yu.V.; Gamalij, E.G.; Krokhin, O.N.; Rozanov, V.B. (AN SSSR, Moscow. Fizicheskij Inst.). *Zh. Eksp. Teor. Fiz.;* **71**: No. 2, 594-602(Aug 1976). (In Russian).

An analytic stationary model of the 'corona' of spherical laser targets is considered by taking into account the major physical processes, viz. hydrodynamic processes, laser radiation absorption in the vicinity of the critical point and electron thermal conductivity. Expressions for the 'corona' parameters are derived as functions of the laser pulse parameters (radiation flux and frequency) and of the target (radius and physical thermal properties).

27691 Increa e of thermonuclear field on fast implosion of cold shell targets by means on nonlinear interaction of laser radiation with plasma. Khora, Kh. *Kvantovaya Elektron. (Moscow);* **3**: No. 2, 293-303(Feb 1976). (In Russian).

The nonlinear interaction force between laser fields and cold plasma shells efficiently transforms radiant energy into mechanical energy of implosion. This transfer of energy has been considered before in numerical experiments and is treated here analytically in a didactic example starting with the inhomogeneous Rayleigh density profile. Up to 50% of the laser energy can be transferred into the energy of compression is a single, untailored pulse of 2.5×10^{16} W/cm^2 intensity and of only a few picoseconds duration is used for spherical illumination of the shell. If the pulse is short enough to reduce collisional thermalization, then the collapse and compression of the plasma can remain both at the threshold of Fermi degeneracy and adiabatic. This results in nuclear reaction gains G, based on the deposited energy, E_0, and without a-particle reheating, of $G=400$ for $E_0=2.25$ kJ (DT), 900 kJ(DD), 13MJ (HB). About 1000 times less laser energy is necessary than in the case of gas dynamic ablation resulting in the same nuclear reaction yields.

27692 Laser-produced dense plasma diagnostics based on spectra of hydrogen-like and helium-like multicharged ions. Aglitskii, E.V.; Boiko, V.A.; Vinogradov, A.V.; Yukov, E.A. *Kvantovaya Elektron. (Moscow);* **1**: No. 3, 579-590(Mar 1974). (In Russian).

Spectra of Mg11, Mg12, Al12, Al13 ions produced while focusing laser radiation on a solid surface have been investigated. Electron density (Nsub(e) approximately 10^{20} cm^{-3}) and the temperature (kTsub(e) approximately 300 eV) of the emission region are determined from relative intensities of allowed and forbidden lines and also from the lines from autoionization levels. This technique may be applied to plasma diagnostics with Nsub(e) approximately 10^{23} cm^{-3} provided under observation spectra of hydrogen- and helium-like ions of higher degree of ionisation.

COMPONENT DEVELOPMENT AND MATERIALS TESTING

27693 (EUR—5602, pp 499-504) **Command interpreter for the Padua data acquisition system.** Bombi, F.; Cavaggion, C.; Polo, A.; Trainito, G. 1976.

From 9. symposium on fusion technology; Garmisch-Partenkirchen, F.R. Germany (14 Jun 1976).

In Proceedings of the 9. Symposium on fusion technology.

A data acquisition and control system for the ETA-BETA experiment is presently under development at the C.G.I. of Padua. The system is based on a local minicomputer TI 960A linked via a telephone line to a host computer (IBM 370/158). The data collected during the experimentation are initially stored on a local disk unit and then transferred into large permanent files of the host computer. The experimentation requires a strict interaction between the operator and the computer. This interaction requires a sequence of operations which change according to the experiment requirements in an unpredictable manner. To avoid a continuous reprogramming of the operation sequence, to achieve a smooth and automated experimentation, a command interpreter which acts as an interface between the software modules performing different tasks and the operator has been implemented. The interpreter reacts to a command by activating a program which, under the operating system supervision, runs as an independent task or as a subroutine dynamically loaded in core. The operating power of the interpreter is enhanced by structure commands which perform looping and conditional branching as in a procedural programming language. The interpreter is open ended in the sense that new commands can be added during the operation and sequences of commands can be grouped in a procedure which can be executed by a single procedure call command. Nesting of structure commands and procedures is virtually unlimited.

27694 (EUR—5602, pp 275-279) **Three-dimensional calculations for the JET mechanical structure.** Bourrier, P.; Deschamps, P.; Hoffmann, A.; Sonnerup, L. (Association Euratom-CEA, Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France). Groupe de Recherches sur la Fusion Controlee; CEA Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France). Dept. de Physique du Plasma et de la Fusion Controlee). 1976.

From 9. symposium on fusion technology; Garmisch-Partenkirchen, F.R. Germany (14 Jun 1976).

In Proceedings of the 9. Symposium on fusion technology.

The purpose of the calculations was to obtain accurate values for the stresses and deformations of the external shell in the JET mechanical structure. The structural analysis system CEASEMT developed in Saclay was used. This system has been developed for the structural problems in the nuclear field and is now well established by experimental validations. The calculations have been performed in several stages. As a result of each calculation, optimizations of the design have been undertaken in order to reduce stresses and displacement values in certain regions of the structure. For the present design, the last calculations have been carried out for the ultimate performances of the machine. The stresses are everywhere acceptable and well within the requirements of section 3 of the A.S.M.E. code for the envisaged stainless steel of the structure. The overall torsional deformation as well as the distribution of displacements are satisfactory for the proper functioning of the toroidal magnet. As a result the JET external shell is deemed to be clearly feasible for the analysed loading cases.

27695 (EUR—5602, pp 505-509) **New developments of the data acquisition system of TFR.** Hennion, F.; Idmtal, J.; Touche, J. (Association Euratom-CEA, Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France). Groupe de Recherches sur la Fusion Controlee; CEA Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France). Dept. de Physique du Plasma et de la Fusion Controlee). 1976.

From 9. symposium on fusion technology; Garmisch-Partenkirchen, F.R. Germany (14 Jun 1976).

In Proceedings of the 9. Symposium on fusion technology.

The data acquisition system for TFR experiment has been in operation since 1973. All digital equipments connected to the T 2000 computer (Telemecanique Informatique) are in CAMAC standard. All results are given to the physicists on the experimental site immediatly after the shot on Tektronix displays.

27696 (EUR—5602, pp 293-298) **Design aspects of a large toroidal stabilizing shell and vacuum liner assembly.** Hucklesby, R.J.; Crawley, H.J.; Skellett, S. (UKAEA Research Group, Abingdon. Culham Lab.). 1976.

From 9. symposium on fusion technology; Garmisch-Partenkirchen, F.R. Germany (14 Jun 1976).

In Proceedings of the 9. Symposium on fusion technology.

The design and manufacturing problems of toroidal shell/liner system with major/minor liner radii of 180/60cm for a High Beta Reversed Field Pinch Device with a maximum plasma current of 2MA, are considered. The stress analysis figures for the shell show that because of the vacuum load the net forces on the bolting system do not impose undue restraints. The key problems on the shell are the electrical insulation and cooling at the overlap, vacuum sealing and for a fabricated vessel the integrity of the welding for high vacuum conditions. Alternatively, a cast aluminium alloy shell should prove an attractive proposition, but is dependent upon satisfactory vacuum properties being achieved. From analysis of the dynamic forces on the liner induced by the magnetic fields diffusing through its wall, the buckling stresses have an adequate margin of safety over the critical case and the problem is one of supporting the liner. Because of the size of the liner and the thin sheet metal construction, manufacturing problems will be concerned with maintaining the overall dimensional accuracy and achieving the high standard of welding required.

27697 (EUR—5602, pp 657-663) **Poloidal distributions of radiation heating and 14 MeV neutron flux at first wall.** Kasai, M.; An, S. (Tokyo Univ. (Japan). Nuclear Engineering Research Lab.); Kondo, S. (Tokyo Univ. (Japan). Faculty of Engineering). 1976.

From 9. symposium on fusion technology; Garmisch-Partenkirchen, F.R. Germany (14 Jun 1976).

In Proceedings of the 9. Symposium on fusion technology.

The poloidal distribution of both the fusion neutron heating and the electromagnetic radiation heating of the first wall of a fusion reactor will be important for a number of reasons, including wall erosion, wall cooling, and maintenance design. A solution of the poloidal distribution of wall loading due to both fusion neutron as well as electromagnetic radiation using formulas of analytical geometry was formulated. This method allows arbitrary specification of the source plasma distribution as well as the shape of the first wall. In the calculations for a tokamak, the optimal wall shape which minimizes the poloidal peaking factor of the wall loading for various distributions of the source plasma, was looked for.

27698 (EUR—5602, pp 483-491) **Effect of vacuum conditions on plasma production and confinement.** Lesnyakov, G.G.; Yuferov, V.B. 1976.

From 9. symposium on fusion technology; Garmisch-Partenkirchen, F.R. Germany (14 Jun 1976).

In Proceedings of the 9. Symposium on fusion technology.

Vacuum conditions inside and outside the plasma are investigated with the plasma being created and then confined. The effects of the divertor operation, the geometry and boundary conditions on the vacuum condition around the plasma are determined.

27699 (EUR—5602, pp 429-440) **Tokamak reactor with servicing capability.** Mitchell, J.T.D. (UKAEA Research Group, Abingdon. Culham Lab.); Hollis, A. (UKAEA Research Group, Harwell. Atomic Energy Research Establishment). 1976.

From 9. symposium on fusion technology; Garmisch-Partenkirchen, F.R. Germany (14 Jun 1976).

In Proceedings of the 9. Symposium on fusion technology.

A conceptual design for a Tokamak reactor with practical facilities for the regular replacement of blanket components after the inevitable damage from neutron irradiation, and fatigue is described. This essential facility has been largely ignored in published fusion reactor designs. One exception is the inertially-confined Saturn proposal. Tokamak and other toroidal closed-line systems have very complex geometries and sub-system requirements, which result in blanket servicing being a very difficult problem. In the concept described the magnet shield is divided into two structures - an outer permanent one with access doors and an inner shield, part of and supporting the blanket inside. Servicing access is horizontally between the toroidal magnet coils, after moving some outer poloidal magnet coils. The reactor, reactor hall, workshops and remote-handling facilities are described, and the servicing requirements discussed. The important servicing operation is the remote replacement of radiation damaged blanket and shield - divided in this design into 20 sectors, each weighing 75-100 tons and 11-12 metres high. Analysis of the operation indicates that if one sector can be replaced during a single weekend - i.e. a period of low power demand - then the annual reactor-generator availability allowing as well for the general plant servicing should be >0.9. This level of availability should meet the requirements of generating authorities but the facilities, equipment and workshops necessary may be complex and expensive.

27700 (EUR—5602, pp 471-481) **Constructive and technological aspects of vacuum system design for demonstration thermonuclear reactor Tokamak.** Odintsov, V.N.; Saksagansky, G.L.; Serebrennikov, D.V. 1976.

From 9. symposium on fusion technology; Garmisch-Partenkirchen, F.R. Germany (14 Jun 1976).

In Proceedings of the 9. Symposium on fusion technology.

The structural scheme, principal constructive and technological features and main characteristics of demonstration thermonuclear reactor Tokamak vacuum system including discharge and external vacuum chambers and pumping facilities are considered. The requirements of discharge chamber materials and design are analysed. The estimations are made of medium and maximum heat loads on first wall and of temperature regimes of various types protective screens. The difficulties are shown accomplishing of changeable non-cooled screens on discharge chamber inner surface. A chamber on the basis of tubular jacket with forced cooling is introduced as a possible variation. The sources and kinetics of neutral gas circulation and accumulation in a reactor vacuum system are analyzed. The required parameters of pumping blocks are defined and a pumping cyclogram is given. The expediency of module-type pumping system is proved in which two modifications of pumping blocks with $2x10^4$ and $2x10^3$ l/s singular action pumping speed for nitrogen are used. The requirements are settled for series characteristics of a set of turbomolecular pumps, considered as a basic type of stationary fusion reactor pumping units. An amount of tritium, stored in the first wall is estimated. A complete table of the reactor vacuum system parameters is given.

27701 (GA-A—14614(Vol.8)) **GAC—ANL TNS scoping studies. Volume VIII. Maintainability studies. Status report for FY-77, October 1, 1976—September 30, 1977.** (General Atomic Co., San Diego, Calif. (USA)). Oct 1977. Contract EY-76-C-03-0167-038. 38p. Dep. NTIS, PC A03/MF A01.

Activities on maintainability aspects of the General Atomic Company (GA) Ignition Test Reactor (ITR) performed by Battelle Columbus Laboratories (BCL) during FY 77 are covered. Several maintainability concepts were reviewed and the hands on approach (external to the shield) combined with remote maintenance appeared to be the best option. Failure rate data were reviewed and much applicable information was found. Further analysis of these data are required to permit extrapolation to the fusion system design stresses and environments. In studies of repair times, a modified Delphi technique was used which is suitable for such efforts at the present stage of the design development. A total of thirteen selected repair scenarios were prepared including vessel wall segment replacement, vessel wall burn-through repair and F-coil coolant line replacement. Two types of ITR design approaches were treated, the proximal shield concept and the expanded shield concept. The former appeared to require shorter repair periods owing to reductions in equipment removal for access and less remote maintenance.

27702 (JAERI-M—6822) **Stress analysis of the bellows and its connection with a thick ring of the vacuum vessel.** Morishita, O.; Takatsu, H.; Takashima, T.; Yamamoto, M.; Ohta, M. (Japan Atomic Energy Research Inst., Tokyo). Dec 1976. 56p. (In Japanese). Dep. NTIS (US Sales Only), PC A04/MF A01.

The vacuum vessel of JT-60 consists of U-shaped bellows and thick rings. The vacuum vessel is loaded not only by an atmospheric pressure but also by various electromagnetic forces, and it is baked out at 500°C and keeps the temperature during a plasma discharge. Large mechanical and thermal stresses are thus caused in the bellows and their connections with the thick rings. Numerical analyses of the mechanical stress due to the forces and the thermal stress due to 500°C bake-out are described, and also estimation of the stresses of the JT-60 vacuum vessel are discussed. 1. The stress of bellows is analyzed by the finite element method. It is replaced by anisotropical plate elements, and the relation between the stress and strain, that is D-matrix, of the anisotropic plate is formulated. 2. A method is presented of obtaining the real stress of bellows from the results of anisotropical plate analysis. 3. The relations between maximum stress and dimentions of the bellows and of the thick ring are formulated. 4. Validity of the above calculation method is confirmed by numerical experiment and small-scale model test. 5. From the stresses of bellows and its connection with a thick ring in JT-60, a connecting structure is proposed to reduce mechanical stress of the connection.

27703 (JAERI-M—6922) **Design study of pumping system for tokamak fusion power reactor.** (Japan Atomic Energy Research Inst., Tokyo). Feb 1977. 27p. (In Japanese). Dep. NTIS (US Sales Only), PC A03/MF A01.

Design study of the pumping system for tokamak fusion power reactor has been carried out. The reactor is pumped through twelve pumping ports. It is assumed that the partial pressures of DT and He at 1000 K in the reactor should be maintained less than 3.33×10^{-4} Torr and 1.67×10^{-5} Torr respectively. The main pump is liquid helium cooled cryopump containing sorption panel for helium pumping. The pumping speeds for DT and He are 1.65×10^6 l.sec^{-1} and 9.98×10^5 l.sec^{-1} respectively. The conductance between the reactor and the cryopump should be more than 7.8×10^5 l.sec^{-1} for DT. To satisfy this condition, inlet diameter of pumping duct should be extended to 2.5 m and the configuration of cooling pipes in pumping duct should be changed from original design. Auxiliary pumping system contains turbo-molecular pump, clean roots pump, mechanical booster pump and diaphragm pump. The mechanical booster pump and the diaphragm pump of auxiliary pumping system are also used as recovery pumping system.

27704 **Energetic aspects of fast-fusion reactors with dense liners of medium velocities (10 to 100 kms^{-1}).** Rioux, C. (Paris-11 Univ., 91 - Orsay (France). Lab. de Physique des Plasmas). pp 527-534 of Plasma physics and controlled nuclear fusion research 1976. Proceedings of the 6. international conference held by the IAEA at Berchtesgaden, 6-13 October 1976. Vol. 3. Vienna; IAEA (1977).

From 6. international conference on plasma physics and controlled nuclear fusion research; Berchtesgaden, F.R. Germany (6 Oct 1976).

See CONF-761012—.

The paper deals with energetic problems of fast fusion reactors in which cylindrical liners implode at 'intermediary' velocities, i.e. 10 to 100 kms^{-1}. The heat transfer between plasma and liner are reduced by a longitudinal magnetic field at $\beta >> 1$. First of all, the global energy regime of the process is studied, for a dense and thin liner, as a function of velocity and thermonuclear combustion rate. Then the results are applied to the model of a simple liner consisting

of a cold, thin metallic tube accelerated by a magnetic field. Finally for this model, orders of magnitude of energies are given that can be applied in the construction of an effective reactor.

GENERAL AND MISCELLANEOUS

MATHEMATICS AND COMPUTERS

REFER ALSO TO CITATION(S) 25900, 26505, 26597

27705 (LA-UR—77-2876) **Image restoration of space variant blurs by sectioned methods.** Trussell, H.J.; Hunt, B.R. (Los Alamos Scientific Lab., N.Mex. (USA); Arizona Univ., Tucson (USA)). 1978. Contract W-7405-ENG-36. 7p. (CONF-780403—1). Dep. NTIS, PC A02/MF A01.

From IEEE international conference on acoustics, speech and signal processing; Tulsa, OK, USA (10 Apr 1978).

Previous work on sectional methods in image processing is extended to the processing of degradations produced by space variant point spread functions. 4 figures.

27706 (SAND—77-1179) **Installation independent version of the Sandia SCORS plot system.** Thompson, S.L.; Ruiz, N.K. (Sandia Labs., Albuquerque, N.Mex. (USA)). Jan 1978. Contract EY-76-C-04-0789. 35p. Dep. NTIS, PC A03/MF A01.

A portable version of the Sandia SCORS plot system is described. The set of computer routines is designed to accompany Sandia programs sent outside of the laboratory, and can generate output for any type of plotter that might be available.

27707 (SAND—77-1684C) **Software development of a real time signal processing system.** Bourgeois, N.A. Jr. (Sandia Labs., Albuquerque, N.Mex. (USA)). 1977. Contract EY-76-C-04-0789. 66p. (CONF-771206—3). Dep. NTIS, PC A04/MF A01.

From Digital signal processing symposium; Albuquerque, NM, USA (6 Dec 1977).

A method of developing real time signal processing assembly language code is described. The technique presented includes the use of fixed point arithmetic. A sample program of a real time nonrecursive adaptive filter followed by an averaging detector is also included.

27708 (SAND—77-1831) **Software documentation guidelines and procedures for Applicon systems.** Burd, W.C.; Carli, G.; Yates, A.L. (Sandia Labs., Albuquerque, N.Mex. (USA)). Jan 1978. Contract EY-76-C-04-0789. 30p. Dep. NTIS, PC A03/MF A01.

Proper documentation and adequate backup procedures for Applicon-supplied and Department 9620-developed Applicon software is required to insure the security and reliability of computer code in which a substantial investment has been made. This report describes the requirements, responsibility, and procedures which have been established to provide this protection. 5 figures.

27709 (UCID—17719) **BBCPLOT users manual.** Litterst, R.F. (California Univ., Livermore (USA). Lawrence Livermore Lab.). Aug 1977. Contract W-7405-ENG-48. 16p. Dep. NTIS, PC A02/MF A01.

BBCPLOT is a sophisticated graphics program which allows the user to analyze BBC data through the use of pictures. The raw data are supplied by either BBC restart dumps or Fractional Volume dumps, and the plots are produced by use of TV80LIB software. There are several types of pictures which the user can have as output from BBCPLOT. The most general type is the 2-D contour plot. This type of picture displays lines of equal value of data (e.g. isotherms, isobars, etc.). Another type of picture is the arrow plot. In this picture an arrow is plotted in a zone to convey the information of direction and magnitude, (e.g. velocity field). Another type of picture is a three-dimensional surface plot. Instead of contour lines, the data are displayed as mountains and valleys. Also available are Fractional Volume plots produced from BBC FV dumps and Profile SnapShot plots produced from BBC CRTSS dump files. Profiles, parallel to the Z or R axis, can be plotted on any of the acceptable variables. BBCPLOT exists on both the 7600 and STAR computers. (RWR)

27710 (UCID—17722) **ACT: an 8080 MACRO processor.** Cecil, A. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 6 Feb 1978. Contract W-7405-ENG-48. 14p. Dep. NTIS, PC A02/MF A01.

ACT is a macro text interpreter which runs under the CP/M floppy disk operating system on a microcomputer which can execute the Intel 8080 instruction set. ACT uses the same scanning algorithm as TRAC (registered trademark of Rockford Research Institute), but ACT has a modified set of primitive functions. ACT has been used to program "smart" terminal operations and to process diskette files.

27711 (UCRL—80078) **Design of stable 2-D half-plane recursive filters using spectral factorization.** Ekstrom, M.P.; Twogood, R.E.; Woods, J.W. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 16 Dec 1977. Contract W-7405-ENG-48. 5p. (CONF-780403—2). Dep. NTIS, PC A02/MF A01.

From IEEE international conference on acoustics, speech and signal processing; Tulsa, OK, USA (10 Apr 1978).

A new design algorithm for two-dimensional (2-D) recursive digital filters is presented, with emphasis on the general class of half-plane filters. A recently developed 2-D spectral factorization procedure and a nonlinear optimization algorithm are incorporated for iterative convergence to a stable, (locally) optimum filter. Details of the computations required in the implementation of the design procedure are presented, in addition to an example of its application.

27712 **Incomplete cholesky - conjugate gradient method for the iterative solution of systems of linear equations.** Kershaw, D.S. (University of California, Lawrence Livermore Laboratory, Livermore, California 94550). *J. Comput. Phys.;* **26**: No. 1, 43(Jan 1978).

A new iterative method for the solution of systems of linear equations has been recently proposed by Meijerink and van der Vorst [1]. This method has been applied to real laser fusion problems taken from typical runs of the laser fusion simulation code LASNEX [2]. These same problems were also solved by various standard iteration methods. On a typical hard problem, the new method is about 8000 times faster than the point Gauss-Seidel method, 200 times faster than the alternating direction implicit method, and 30 times faster than the block successive overrelaxation method with optimum relaxation factor. The new method has two additional virtues. (1) Most of the algorithm is trivially vectorizable with a vector length equal to the full dimension of the system of linear equations. Thus, great savings are possible on vector machines. (2) The new method has a universal scope of application for solution of implicitly differenced partial differential equations. The only restrictions are that the matrix be symmetric and positive definite. The algorithm of Meijerink and van der Vorst which applied only to positive definite symmetric M-matrices is generalized to apply to nonsingular matrices arising from partial differential equations. A general description of the method is given. Numerical results are discussed and presented, and an explanation is given for the success of the method.

27713 **Collocation methods for integro-differential equations.** Hangelbroek, R.J.; Kaper, H.G.; Leaf, G.K. (Argonne National Lab., IL). *SIAM J. Numer. Anal.;* **14**: No. 3, 377-390(Jun 1977).

The work of de Boor and Swartz [SIAM J. Numer. Anal., 10 (1973), pp. 582-606] on the solution of two-point boundary-value problems by collocation is extended. Particular emphasis is on boundary-value problems described by integro-differential equations involving derivatives of order up to and including m with m boundary conditions. The approximation of (isolated) solutions by means of piecewise polynomial functions of degree less than m + k possessing m-1 continuous derivatives is studied. If the problem is sufficiently smooth and the solution has m + 2k continuous derivatives, then one can achieve O[absolute value (Δ)]/sup k+m/ global convergence by collocating at the zeros of the kth Legendre polynomial relative to each subinterval. At the knots, the approximation and its first m-1 derivatives are O[absolute value(Δ)]/sup 2k/ accurate.

27714 **Nonuniqueness of best approximating complex rational functions.** Saff, E.B.; Varga, R.S. *Bull. Am. Math. Soc.;* **83**: No. 3, 375-377(May 1977).

For any real continuous function f(x) on [-1,1] and for any nonnegative integer n, it is well known that the best uniform approximation to f(x) on [-1,1] by a real rational function of order n is unique. On the other hand, it has been shown that there can be a continuous complex-valued function on a certain compact crescent-shaped region in the plane whose best uniform complex rational approximation of order 1 is not unique. The present work shows that this nonuniqueness of best complex rational approximations can hold even in the case of approximating real functions on finite real intervals. The examples given point out a somewhat unexpected fact; namely, that complex rational functions may yield closer uniform approximations to a real function on [-1,1] than the best real rational function of the same type. (RWR)

27715 **Permutations of the positive integers with restrictions on the sequence of differences.** Slater, P.J.; Velez, W.Y. (Sandia Labs., Albuquerque, NM). *Pac. J. Math.;* **71**: No. 1, 193-196(1977).

Let [a/sub k/] be a sequence of positive integers and d/sub k/ = absolute value of (a/sub k+1/ - a/sub k/). It is said that [a/sub k/] is a permutation if every positive integer appears once and only once in the sequence [a/sub k/]. The following theorem is proved: let [m/sub i/] be any sequence of positive integers; then there exists a permutation [a/sub k/] such that the absolute value of the set of all k such that d/sub k/ = i is equal to m/sub i/.

27716 Geometric overconvergence of rational functions in unbounded domains. Saff, E.B.; Varga, R.S. *Pac. J. Math.;* **62**: No. 2, 523-549(1976).

The phenomenon of overconvergence for rational functions converging geometrically on [0, + infinity) is studied.

INFORMATION HANDLING

27717 (LA-UR—77-2739) Using system 2000 with proposed ANSI standards for data exchange. Benkovitz, C.M.; Wiley, R.A. (Los Alamos Scientific Lab., N.Mex. (USA)). 1977. Contract W-7405-ENG-36. 27p. (CONF-771074—2). Dep. NTIS, PC A03/MF A01.

From Association of System 2000 Users for technical exchange fall conference; San Francisco, CA, USA (19 Oct 1977).

In 1976 the Energy Research and Development Administration (ERDA) Interlaboratory Working Group for Data Exchange developed a standard for the generalized exchange of data bases using magnetic tape. This subsequently became the proposed "American National Standard Specifications for an Information Interchange Data Descriptive File." This report describes the development of a mechanism for conversion of SYSTEM 2000 data bases to or from interchange files conforming to the proposed standard and vice versa. Two phases are discussed. Phase One requires that the user supply the data-base definition, and uses loader string files for conversion. Phase Two will be a completely automated process using the Programming Language Interface. This phase requires no prior knowledge of the data-base structure or content at execution time.

CORPORATE INDEX

In the Corporate Index, report literature is indexed using the name of the organization or institution responsible for issuing the report. Headings are provided for all report literature and for published literature for which a corporate approach is especially desirable, e.g., symposium and conference proceedings.

Each entry under a corporate heading gives the report title and the volume and abstract numbers. Report numbers, if applicable, are given in parentheses at the end of the entry.

DOE Energy Information Data Base: Corporate Author Entries (TID-4585) is used in the standardization of corporate entries. TID-4585 is available for purchase from the National Technical Information Service (NTIS), U. S. Department of Commerce, Springfield, Virginia 22161.

A

Aerospace Corp., El Segundo, Calif. (USA). Aerophysics Lab.
Annular iodine laser facility. Interim report, 3:26717 (AD-A—042282)
Review of rate coefficients in the D_2-F_2 chemical laser system. Interim report, 3:26731 (AD-A—043812)
Simple model of a chain-reaction pulsed HF laser. Interim report, 3:26728 (AD-A—043319)
Temporal stability of single-line cw HF chemical laser with unstable resonator. Interim report, 3:26722 (AD-A—042458)

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Infrared emissivities of micron-sized particles of C, MgO, Al_2O_3, and ZrO_2. Final report, 3:26636 (AD-A—042144)

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Project STRESS satellite communication test results. Final technical report, June 1976—March 1977, 3:27041 (AD-A—043873)

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EXCEDE II. Environmental research papers, 3:27035 (AD-A—042491)

Alabama Univ., Huntsville (USA). Kenneth E. Johnson Environmental and Energy Center
Solar heating and cooling demonstration program contractor's review. Summary and analysis of workshop and panel sessions, 3:26044 (CONF-771229—(Summ.))

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Cadmium stannate selective optical films for solar energy applications. Semi-annual progress report 1 Jan—30 Jun 75, 3:25994 (PB—273038)

American Society of Mechanical Engineers, New York
Strategy for energy conservation through tribology, 3:26706 (TID—28175)

Ames Lab., Iowa (USA)
Decay of mass-separated ^{122}Ag to levels in ^{122}Cd, 3:27363 (IS-T—795)
Excess Gibbs free energy and the activity coefficients of the $Nd(NO_3)_3$—HNO_3—H_2O system at 25°C, 3:26671 (IS-M—125)
Laser two-proton excited fluorometric detection for high pressure liquid chromatography, 3:26837 (IS-T—792)
Proceedings of the 14th annual electron microscopy colloquium, 3:26952 (CONF-770504—)
Unified model studies of N = 84 and N = 80 nuclei, 3:27367 (IS-T—793)

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Solar energy-uses-systems-experience symposium and roundtable conference, 3:26043 (CONF-770246—)

Argonne National Lab., Ill. (USA)
Advanced fuel cell development. Progress report, July—September 1977, 3:26542 (ANL—77-79)
Bubble dynamics in a superheated liquid, 3:26277 (ANL—77-20)
Comparison of anti p anti p and pp luminosities at Fermilab, 3:27215 (ANL-HEP-CP—77-81)
Cost/effectiveness analysis of the Illinois ozone episode regulation (R75-4). Final Report, 3:26890 (PB—270896)
Crossing geometry for Main Ring on Doubler collisions, 3:26802 (ANL-HEP-CP—77-60)
Failure of the thermocouple assembly from the HYGAS coal pretreatment vessel: failure analysis report, 3:25621 (ANL/MSD/FE—77-6R)
Federal battery program for transportation uses, 3:26485 (CONF-7606127—1)
Final report on TREAT Test R3, a single-pin loss-of-flow experiment, 3:26432 (ANL—77-54)
National coal utilization assessment: modeling long-term coal production with the Argonne coal market model, 3:25720 (ANL/AA—13)
National coal utilization assessment: the price and availability of low sulfur coal in eastern markets, 3:25719 (ANL/AA—12)
Physics Division annual review, 1 April 1976—31 March 1977, 3:27312 (ANL—77-60)
SAREF Project. Volume I. Conceptual design report, 3:26421 (ANL/SAREF—75-1)
Sodium flow calibration using a pulsed neutron activation technique on a 400mm (16 inch) pipe at LMEC, 3:26278 (ANL-CT—78-9)

Summary and evaluation of fuel dynamics transient-overpower experiments: status 1974, 3:26431 (ANL—77-44)
Arizona Univ., Tucson (USA)
Image restoration of space variant blurs by sectioned methods, 3:27705 (LA-UR—77-2876)
Army Construction Engineering Research Lab., Champaign, Ill. (USA)
Effects of fast and thermal neutron flux and gamma radiation on the transmission characteristics of optical fibers. Interim report, 3:26659 (AD-A—042429)
Market evaluation study: solar heating and domestic hot water heating in DOD buildings. Final report, 3:26042 (AD-A—042178)
State of the art in fiber optics communications and data transfer. Interim report, 3:26660 (AD-A—042579)
Technology evaluation of Army-scale waste-to-energy systems, 3:25973 (AD-A—042578)
Army Electronics Command, Fort Monmouth, N.J. (USA)
Radiation degradation susceptibility of several related polymers. Research and development technical report, 3:26693 (AD-A—042525)
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Army Materials and Mechanics Research Center, Watertown, Mass. (USA)
Materials technology assessment for Stirling engines, 3:26578 (CONS/1011—22)
Army Mobility Equipment Research and Development Center, Fort Belvoir, Va. (USA)
Decontamination of water containing chemical and radiological warfare agents by reverse osmosis. Technical report Jul—Nov 76, 3:26933 (AD-A—046203)
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Rainout, 3:26886 (AD-A—046201)
ASEA, Inc., White Plains, N.Y. (USA)
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Ashland Synthetic Fuels, Inc., Ky. (USA)
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Association Euratom-CEA, Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France). Groupe de Recherches sur la Fusion Controlee
Eigenmode field structure of the fast magnetosonic wave in a Tokamak and loading impedance of coupling structures, 3:27428 (EUR-CEA-FC—886)
Identification of Mo XV to Mo XXXIII in the soft X-ray spectrum of the TFR Tokamak, 3:27490 (EUR-CEA-FC—887)
Plasma-wall interactions in the TFR machine, 3:27611 (EUR-CEA-FC—889)
Association Euratom-CEA, Centre d'Etudes Nucleaires de Grenoble, 38 (France). Groupe de Recherches sur la Fusion Controlee
Alumina-plasma interaction in the PETULA Tokamak, 3:27608 (CEA-CONF—3860)
Heating of toroidal plasmas, 3:27426 (CEA-CONF—3863)
Plasma energy balance in PETULA experiment, 3:27500 (CEA-CONF—3859)
Source of low energy neutrals (1 to 4kV) for the production of negative ions, 3:27652 (CEA-CONF—3864)
Sources for high frequency heating. Performance and limitations, 3:27653 (CEA-CONF—3865)
Association Euratom-CEA sur la Fusion, Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France). Dept. de Physique du Plasma et de la Fusion Controlee
Description of the fast moving limiter used with T.F.R., 3:27612 (EUR-CEA-FC—893)
Note on the characters of the dispersion equation of fast magnetosonic wave near the second ion-cyclotron harmonic, 3:27561 (EUR-CEA-FC—895)
Association Euratom-KFA, Juelich (Germany, F.R.)
Calculations of the laserlight-transmission in laser-fusion-reactors at various densities and density-profiles, 3:27668 (Juel—1399)
Atomics International Div., Canoga Park, Calif. (USA)
Evaluations of the piping system inelastic analysis computer program PIRAX2, 3:26276 (AI-DOE—13216)
Sodium technology and cover gas seal development programs. Quarterly technical progress report, July—September 1977, 3:26274 (AI-DOE—13208)
Sodium-to-gas leak detection. Annual technical progress report, government fiscal year 1977, 3:26275 (AI-DOE—13211)
Atomics International Div., Golden, Colo. (USA). Rocky Flats Plant
Application of a GC/MS data system at Rocky Flats, 3:26839 (RFP—2558)
Displacement technique for calibration for special nuclear material tankage volumes, 3:26840 (RFP—2627)
Joint ANSI-INMM 8.1: Nuclear Regulatory Commission study of uranium hexafluoride cylinder material accountability bulk measurements, 3:25953 (RFP—2634)
Avco-Everett Research Lab., Everett, Mass. (USA)
Metal vapor visible laser kinetics program. Final technical report, 3:26716 (AD-A—042271)
Temperature, stress and optical phase difference for a window transmitting a cw laser beam. Research report, 3:26726 (AD-A—042671)
Avco Systems Div., Wilmington, Mass. (USA)
Diagnostic motor vehicle inspection demonstration projects, program engineering support. Volume 7. Appendix f. Fuel economy evaluation. Final report November 1974—December 1976, 3:26587 (PB—270995)

B

Babcock and Wilcox Co., Alliance, Ohio (USA). Research Center
Characteristics of solvent refined coal: dual register burner tests. Final report, 3:25711 (EPRI-FP—628)
Babcock and Wilcox Co., Lynchburg, Va. (USA)
Containment for small pressurized water reactors, 3:26227 (CONF-771109—90)
Improvement of the mechanical reliability of monolithic refractory linings for coal gasification process vessels. Bimonthly letter progress report, October—November 1977, 3:25630 (FE—2218-15)
Baker (Michael), Jr., Inc., Beaver, Pa. (USA)
State-of-the-art of FGD sludge fixation. Final report, 3:25680 (EPRI-FP—671)
Ballistic Research Labs., Aberdeen Proving Ground, Md. (USA)
Coupling of x-ray deposition to structural response. Final report, 3:27398 (AD-A—042667)
Battelle Columbus Labs., Ohio (USA)
Energy efficiency improvement target for SIC 34. Fabricated metal products. Volume 1. Draft target support document, 3:26557 (PB—269812)
Energy efficiency improvement target for SIC 34. Fabricated metal products. Volume 2. Revised target support document, 3:26558 (PB—269813)
Energy efficiency improvement target for SIC 32: stone, clay, and glass products. Volume 1. Draft report. Research report, 3:26562 (PB—269880)
Energy efficiency improvement target for SIC 32: stone, clay, and glass products. Volume 2. Draft report. Appendices. Research report, 3:26563 (PB—269881)
Energy efficiency improvement target for SIC 32: stone, clay, and glass products. Volume 4. Final report. Research report, 3:26565 (PB—269883)
Energy efficiency improvement target for SIC 32: stone, clay, and glass products. Volume 3. Draft report. Appendices. Research report, 3:26564 (PB—269882)
Energy efficiency improvement targets for primary metal industries. SIC 33. Volume I. Draft target support document, 3:26559 (PB—269823)
Energy efficiency improvement targets for primary metal industries. SIC 33. Volume III. Final target report, 3:26561 (PB—269825)
Energy efficiency improvement targets for primary metal industries. SIC 33. Volume II. Draft target support document. Appendices, 3:26560 (PB—269824)

Environment of Amchitka Island, Alaska, 3:26895 (TID—26712)
Evaluation of materials for use in letdown valves and coal feed pumps for coal liquefaction service. Final report, 3:25647 (EPRI-AF—579)
Laser spectroscopy for continuous combustion applications, 3:26700 (BMI—1982)
Potential environmental impact of compounding and fabricating industries: a preliminary assessment. Final report, 3:26936 (PB—273603)
Source assessment: pressed and blown glass manufacturing plants. Final task report Sep 75—Jan 77, 3:26882 (PB—273788)
Technology facility siting characteristics and infrastructure needs. Final report, 3:26940 (PB—270899)

Battelle Human Affairs Research Center, Seattle, Wash. (USA)
Public values associated with nuclear waste disposal, 3:25935 (BNWL—1997)

Battelle-Institut e.V., Frankfurt am Main (Germany, F.R.)
Scenarios chemical technology, 3:26555 (BMFT-FB-T—77-01)

Battelle Pacific Northwest Labs., Richland, Wash. (USA)
Alternative electrical transmission systems and their environmental impact, 3:26200 (PB—271652)
Calculation of population distribution using a computer data base, 3:26939 (BNWL—2395)
Detailed accident analysis for the high level waste preparation phase of the commercial nuclear waste vitrification project, 3:26989 (BNWL—2207)
Ecology of the 200 Area plateau waste management environs: a status report, 3:25943 (PNL—2253)
Environmental assessment methodology for the nuclear fuel cycle, 3:26873 (BNWL—2219)
Estimation of air concentrations due to the diffusion, deposition and resuspension of contaminants by the wind, 3:26883 (PNL—2426)
Fracture mechanics of thin wall cylindrical pressure vessels: an interim review, 3:26442 (PNL—2417)
Hanford critical radiation dosimeter, 3:26826 (PNL—2276)
Management of social and economic impacts associated with the construction of large-scale projects: experiences from the Western coal development communities, 3:26496 (BNWL-RAP—16)
Population dose commitments due to radioactive releases from nuclear power plant sites in 1975, 3:26992 (PNL—2439)
Revegetation of a waste disposal site in the 200 areas of the Hanford Reservation, 3:26908 (PNL—2454)

Bechtel Corp., San Francisco, Calif. (USA)
Analysis of coal hydrogasification processes. Monthly technical progress report, 1 December—31 December 1977, 3:25639 (FE—2565-10)
Coal gasification study handbook. Final report, 3:25620 (AD-A—042385)

Bechtel Power Corp., San Francisco, Calif. (USA)
Combined cycle power plant, capital cost estimates. Final report, 3:26189 (EPRI-AF—610)

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Digital analysis of EBW burst wave forms. Final report, 3:26845 (BDX—613-1668(Rev.))
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Quarterly technical progress report, October—December 1977, 3:25631 (FE—2240-79)

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20 GeV e^+ x 400 GeV p: some synchrotron radiation considerations, 3:26805 (BNL—23533)
Brookhaven National Laboratory Burner-Boiler/Furnace Efficiency Test Project. Hydronic equipment findings report reference manual, 3:26777 (BNL—50644)
Cathode cooling systems for the magnetron and Penning H^- sources: a progress report of work at Brookhaven National Laboratory, 3:26801 (BNL—23654)
Chemical composition of sulfate as a function of particle size in New York summer aerosol, 3:26872 (BNL—23672)
Choice of harmonic number for the ISABELLE accelerating rf system, 3:26807 (BNL—23535)
Comparative effects of coal and nuclear fuel on mortality, 3:26871 (BNL—23579)
Dependence of anti W on the charge of heavy ions, 3:27057 (BNL—23394)
Exotic 4π detector for ISABELLE, 3:26806 (BNL—23534)
Experimental limits on heavy lepton production by neutrinos, 3:27106 (BNL—23513)
Genus nicotiana as a genetic resource. Chapter 1, 3:26967 (BNL—23558)
High energy neutral injectors based upon negative ion plasma sources, 3:26800 (BNL—23653)
ISABELLE machine glossary, 3:26809 (BNL—23538)
Muon shield requirements for ISABELLE at 400 GeV/c, 3:26810 (BNL—23539)
Neutralization of positive particle beams by electron trapping, 3:26795 (BNL—23655)
New states below 2.2 GeV observed in $e^+ e^-$ annihilations, 3:27136 (BNL—23612)
Panel on reference nuclear data and surveys of reference data requirements, 3:27313 (BNL-NCS—50717)
Present status of negative ion acceleration and transportation from SP sources, 3:26799 (BNL—23652)
Prosaic use of stochastic cooling at ISABELLE, 3:26804 (BNL—23532)
Rate parameters for the reactions of formaldehyde with H-atoms and O-atoms over the temperature range 250 to 470 K, 3:26670 (BNL—23550)
Regeneration of lime-based sorbents in a kiln with solid reductants, 3:25710 (BNL—23765)
Surface transparent potentials: forward angle transfer and backward angle elastic scattering in heavy-ion collisions, 3:27338 (BNL—23461)
Time required to replace an ISABELLE ring magnet, 3:26808 (BNL—23536)

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Exotic 4π detector for ISABELLE, 3:26806 (BNL—23534)

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Cellulose, food and energy, 3:26021 (LBL—5275)
Initial results with the Berkeley on-line mass separator-RAMA, 3:26803 (LBL—7156)
1K delay line digitizer, 3:26830 (LBL—7215)
Nuclear collisions at very high energy, 3:27147 (LBL—6597)
Priori predictive methods of assessing health effects of chemicals in the environment, 3:26878 (LBL—6372)
Proton and pion spectra at large angles in relativistic heavy-ion collisions, 3:27332 (LBL—670)
Status of the LBL/LLL development program, 3:27658 (LBL—6830)
Study of the fermentation of xylose to ethanol by fusarium oxysporum, 3:26022 (LBL—6351)
Viscosity of aqueous sodium chloride solutions from 0 to 150°C, 3:26114 (LBL—5931)
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Approximate method for determining the influence of water and porosity on the Gruneisen gamma, 3:26647 (UCRL—76010)
Automation of the national water quality laboratories, U.S. Geological Survey 2: design concepts for achievement of automation objectives, 3:27017 (UCRL—52295(Pt.2))
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Design of stable 2-D half-plane recursive filters using spectral factorization, 3:27711 (UCRL—80078)
Effects of underground coal gasification on ground-water quality, 3:25644 (UCRL—80145)
Electric Hybrid Vehicle Program contractors' coordination meeting: summary, oversight, and review, 3:26581 (UCRL—13805)
Energy and Resource Planning Group FY 1977 annual report, 3:26495 (UCRL—50029-77)
Energy and technology review, 3:27673 (UCRL—52000-77-8)
Gamma-ray dosimetry errors with TLDs, 3:26827 (UCRL—80183)
Habitat requirements and population characteristics of the clapper rail (Rallus longirostris yumanesis) in the Imperial Valley of California, 3:26943 (UCRL—13813)
Hazard analysis of uranium inhalation at the Lawrence Livermore Laboratory, 3:26998 (UCID—17673)
Instrumenting a pressure suppression experiment for a MK I boiling water reactor: another measurements engineering challenge, 3:26444 (UCRL—52314)
Iterative reconstruction of underground refractive index distributions from cross-borehole transmission data, 3:27006 (UCRL—52348)
Laser driven fusion fission hybrids, 3:27681 (UCRL—79653(Rev.1))
PATRIC: a three dimensional particle-in-cell sequential puff code for modeling the transport and diffusion of atmospheric pollutants, 3:26884 (UCID—17701)
Plasma polymerization coating of D-T filled glass shells for laser fusion targets, 3:27682 (UCRL—80162)
Ponderomotive force in a hydrodynamic simulation code, 3:27093 (UCRL—79860)
Properties of benzotrifuroxan, 3:26846 (UCRL—52353)
Rare earth vapor laser studies, 3:27680 (UCRL—79364)
SHIVA Nd: glass disk-amplifier-assembly facility and special purpose fixtures, 3:27671 (UCID—17703)
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Target-plasma production by laser irradiation of a pellet in the Baseball II-T experiment, 3:27531 (UCRL—52363)
Theoretical model for two-phase fuel injection in stratified charge engines, 3:26588 (UCRL—79534)
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Plasma-wall interactions in the TFR machine, 3:27611 (EUR-CEA-FC—889)
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Alumina-plasma interaction in the PETULA Tokamak, 3:27608 (CEA-CONF—3860)
Heating of toroidal plasmas, 3:27426 (CEA-CONF—3863)
Plasma energy balance in PETULA experiment, 3:27500 (CEA-CONF—3859)
Source of low energy neutrals (1 to 4kV) for the production of negative ions, 3:27652 (CEA-CONF—3864)

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Water resources appraisal for hydroelectric licensing. Evaluation report, project No. 287, 3:25976 (NP—22951)
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Emergency natural gas purchases: actions needed to correct program abuses and consumer inequities, 3:25862 (EMD—78-10)
First Federal attempt to demonstrate a synthetic fossil energy technology: a failure, 3:26519 (EMD—77-59)
National energy policy: an agenda for analysis, 3:26515 (EMD—77-16)
Net energy analysis: little progress and many problems, 3:26494 (EMD—77-57)
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Alfven wave instability stabilization in a two-component tokamak, 3:27541 (IAE—2650)
Neutrals escape on a wall due to charge exchange while neutral beam injection into a toroidal plasma, 3:27429 (IAE—2520)
Quasy - linear theory of satellite interaction of alphaparticles with Alfven waves in a tokamak, 3:27564 (IAE—2655)
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Magnetics design for ripple-assisted beam injection into the ISX-B and TFTR Tokamaks, 3:27592 (CONF-771029—203)

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FSAR amendment 10, 3:26436 (HEDL-TI—75002-10)
Laboratory quality assurance and its role in nuclear fuel reprocessing and refabrication, 3:26661 (HEDL-SA—1258)
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Natural gas content of geopressured aquifers, 3:25826 (CONF-771153—1)
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Design study of electrical power supply system for tokamak fusion power reactor, 3:27649 (JAERI-M—6803)
Design study of pumping system for tokamak fusion power reactor, 3:27703 (JAERI-M—6922)
Design study of superconducting poloidal magnets for tokamak fusion power reactor, 3:27633 (JAERI-M—6802)
Design study of superconducting toroidal field magnet for tokamak fusion power reactor, 3:27634 (JAERI-M—6921)
Detection of the position and cross-section of a tokamak plasma with magnetic probes, 3:27468 (JAERI-M—6931)
Diagnostics of a scrape-off layer plasma, 3:27613 (JAERI-M—6971)
Dielectronic recombination of carbon, oxygen and iron in low-density and high-temperature plasmas, 3:27505 (JAERI-M—7019)
Eddy currents induced on the torus with non-uniform resistances, 3:27635 (JAERI-M—6953)
Effect of plasma minor-radius expansion in the current build-up phase of a large tokamak, 3:27615 (JAERI-M—7014)
Electrostatic diagnostics of JFT-2a (DIVA), 3:27467 (JAERI-M—6861)
Heat analysis of the magnetic limiter plate for JT-60, 3:27614 (JAERI-M—7013)
Numerical studies of lower hybrid wave propagation in JFT-2, 3:27566 (JAERI-M—6902)
Stress analysis of the bellows and its connection with a thick ring of the vacuum vessel, 3:27702 (JAERI-M—6822)
Study on plasma ignition of JAERI experimental fusion reactor, 3:27432 (JAERI-M—6876)
Temperature gradient effect on impurity-ion transport, 3:27504 (JAERI-M—6965)
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Impacts of the national energy programme on solar economics, 3:26051 (LA-UR—78-131)
Integrated minicomputer alpha analysis system, 3:26888 (LA-UR—77-2968)
Jupiter energetic particle experiment ESAD proton sensor design, 3:26818 (LA—7009-MS)
Laser synthetic chemistry, 3:26692 (LA-UR—77-2790)
Performance characteristic of discharge excited excimer lasers, 3:26737 (LA-UR—77-328)
Photon and beta response of a new thermoluminescent dosimeter badge, 3:26824 (LA-UR—77-3001)
Possible uranium—ruthenium method for measurement of ore age, 3:25903 (LA-UR—77-2863)
Prospects for solar energy: the impact of the National Energy Plan, 3:25985 (LA—7064-MS)
Status of European thermochemical hydrogen programs, 3:25959 (LA-UR—77-2985)
System of nonlinear partial differential equations describing cylindrical plasma collapse, 3:27506 (LA—6824)
TRIDENT: a new triangular mesh discrete ordinates code, 3:27616 (LA-UR—77-2511)
Uranium solubilities in the Oklo reactor zones, 3:27016 (LA-UR—77-2818)
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Approximate method for predicting temperature distribution in wire wrapped fuel assemblies of a LMFBR, 3:26280 (COO—2245-37TR)
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Ion extraction from high electron temperature plasma and mass analysis, 3:27656 (IPPJ-DT—49)
Lithium ion source of thermionic emission type, 3:27657 (IPPJ-DT—51)
Possibility of medium energy neutral beam injection into stellarator reactor, 3:27430 (IPPJ—252)
Roles of turbulence on plasma heating, 3:27431 (IPPJ—255)
Stress analysis of supporting tube of helical winding in stellarator device, 3:27632 (IPPJ-T—25)

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Black chrome on commercially electroplated tin as a solar selective coating, 3:26061 (ERDA/NASA/1060—77/1)
Materials technology assessment for Stirling engines, 3:26578 (CONS/1011—22)
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Catalytic and structural properties of the pentafunctional/arom/enzyme conjugate, 3:26944 (CONF-780108—1)
Chemical thermodynamics of the system Cs—U—Zr—H—I—O in the LWR fuel-clad gap, 3:26211 (ORNL/TM—6130)
Comparative metabolism of benzo(a)pyrene in rodent liver and embryonic cells in tissue culture, 3:26995 (CONF-771147—2)
Corrections and revisions to the FORTRAN IV version of the Wisconsin Hydrologic Transport Model, 3:27003 (ORNL/NSF/EATC—29)
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Magnetics design for ripple-assisted beam injection into the ISX-B and TFTR Tokamaks, 3:27592 (CONF-771029—203)
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Procedures for the detection of unscheduled DNA synthesis in the germ cells of mole mice exposed in vivo to chemical mutagens, 3:26996 (TID—28142)
PWR Blowdown Heat Transfer Separate-Effects Program. Thermal-Hydraulic Test Facility experimental data report for test 105, 3:26440 (ORNL/NUREG/TM—143)
Realistic calibration of whole body counters for measuring plutonium, 3:26817 (IAEA-SM—222/57)
Shallow land burial of low-level radioactive wastes, 3:25938 (ORNL/EIS—115)
Small radius start-up of tokamak plasmas with a moving limiter, 3:27435 (ORNL/TM—6111)
Standardized radioactive decay data sets for use in radiation dosimetry, 3:26991 (IAEA-SM—222/51)
Technical specifications for the Oak Ridge Research Reactor, 3:26422 (ORNL/TM—5999)
Transport and transformation pathways of hazardous chemicals from solid waste disposal, 3:26875 (CONF-7710114—1)
User's instructions for preliminary version of the CONCEPT-5 computer code, 3:26190 (ORNL/TM—6230)
Value of energy storage for direct-replacement solar thermal power plants, 3:26032 (CONF-780216—2)
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Development of an aging integrator for uranium-0.75 weight percent titanium alloy part aging control, 3:26595 (Y—2101)
Performance tests of the ORGDP radiation detection instruments, 3:26821 (Y/DD—215)
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Magnetics design for ripple-assisted beam injection into the ISX-B and TFTR Tokamaks, 3:27592 (CONF-771029—203)
Numerical calculations of transport in ALCATOR, 3:27507 (PPPL—1411)
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Degradation of EMP hardening devices, 3:26841 (SAND—77-0841)
Effects of mineral matter on the hydroliquefaction of coal, 3:25663 (SAND—77-1558C)
Environment of Amchitka Island, Alaska, 3:26895 (TID—26712)
High resolution time resolvable flash x-radiography system, 3:27670 (SAND—77-1587C)
HPBN development, 3:26632 (SAND—782076C)
Hydrogen consumption in non-catalyzed coal liquefaction, 3:25664 (SAND—77-1560C)
Installation independent version of the Sandia SCORS plot system, 3:27706 (SAND—77-1179)
Laser ray trace and bi-directional reflectometry measurements of various solar concentrators, 3:26062 (SAND—77-1466C)
Relation between fuel motion and detector response for in-core fuel motion detection systems, 3:26358 (SAND—77-0533C)
Software development of a real time signal processing system, 3:27707 (SAND—77-1684C)
Software documentation guidelines and procedures for Applicon systems, 3:27708 (SAND—77-1831)
User/programmer guide for UCMD 47: thin film resistor layout, 3:26775 (SAND—77-2035)
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Toroidal equilibrium of reverse field pinch, 3:27501 (CLM-R—164)
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CC80-A microcomputer crate controller for CAMAC, 3:26842 (SLAC-PUB—1840)
Comments on the tau heavy lepton, 3:27110 (SLAC-PUB—1991)
Constituent models and large transverse momentum reactions, 3:27107 (SLAC-PUB—1733)
Deep inelastic electron and muon scattering, 3:27169 (SLAC-PUB—1613)
Drift chamber and pulse height readout systems using analog multiplexing, 3:26831 (SLAC-PUB—1844)
e^+e^- annihilation into hadrons at SPEAR, 3:27098 (SLAC-PUB—1624)
e^+e^- hadron production and jet structure at SPEAR, 3:27171 (SLAC-PUB—1814)
e^+e^- interactions, 3:27170 (SLAC-PUB—1643)
Evidence for, and properties of, the new charged heavy lepton, 3:27109 (SLAC-PUB—1923)
Evidence for, and properties of the tau lepton, 3:27112 (SLAC-PUB—2055)
Fast pulse beam generation systems for electron accelerators, 3:26797 (SLAC-PUB—1948)
Glow discharge processing vs bakeout for aluminum storage ring vacuum chambers, 3:26815 (SLAC-PUB—2053)
High energy photon response of moderated neutron detectors, 3:26820 (SLAC-PUB—1768)
Impact of quantum electrodynamics, 3:27255 (SLAC-PUB—1699)
Large transverse momentum phenomena, 3:27205 (SLAC-PUB—2009)
Nonresonant multibody production by e^+e^- annihilation, 3:27101 (SLAC-PUB—1745)
Opportunities to produce coherent soft x-rays at Stanford, 3:26740 (RLO/2230/T4—191)
PEP main ring magnet system, 3:26814 (SLAC-PUB—2045)
Present and future colliding beam facilities at SLAC, 3:26813 (SLAC-PUB—1971)
Production of new particles and muon-electron events in e^+-e^- annihilation at spear, 3:27100 (SLAC-PUB—1737)
Progress in K spectroscopy, 3:27217 (SLAC-PUB—1980)
Quantum lifetime in electron storage rings, 3:26811 (SLAC-PUB—1884)
Quark confinement, 3:27206 (SLAC-PUB—2020)
Recent developments in the theory of large transverse momentum processes, 3:27119 (SLAC-PUB—1806)
Recent results on new particle production at SPEAR, 3:27137 (SLAC-PUB—1998)
Relativistic interactions in nuclei and the approach to scaling in deep inelastic scattering, 3:27390 (SLAC—203)
RF system for the PFP storage ring, 3:26812 (SLAC-PUB—1898)
Search for heavy particles, 3:27184 (SLAC-PUB—1891)
Similarities among the radiation fields at different types of high energy accelerators, 3:26796 (SLAC-PUB—1805)
Some results in μh^{+-} X process, 3:27108 (SLAC-PUB—1822)
Summary talk: neutrino '77, 3:27111 (SLAC-PUB—1996)
Three generations of quarks and leptons, 3:27240 (SLAC-PUB—1974)
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Power loss problems in EXTRAP coil systems, 3:27639 (TRITA-PFU—77-02)
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Union Carbide Corp., Oak Ridge, Tenn. (USA). Office of Waste Isolation
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Compact poloidal divertor reference design for TNS, 3:27621 (WFPS-TME—055)
Lateral support structure for constant tension D-shaped coils in tokamak fusion devices, 3:27643 (WFPS-TME—063)
Structural analysis methods and design solutions for OHMIC heating solenoids, 3:27641 (WFPS-TME—045)
Trade study analysis for TNS tokamaks, 3:27642 (WFPS-TME—056)
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Effect of a liquid ISSEC on radiation damage parameters in laser fusion reactor first walls, 3:27619 (UWFDM—205)

Toroidal field magnet system utilizing normal metal trimming coils, 3:27640 (UWFDM—225)
Use and performance of graphite and metal ISSECs in tokamak fusion reactors, 3:27618 (UWFDM—202)
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Y

Yale Univ., New Haven, Conn. (USA)
Muon shield requirements for ISABELLE at 400 GeV/c, 3:26810 (BNL—23539)

AUTHOR INDEX

Authors' surnames are indexed in the form appearing in the abstracted publication; given names are reduced to initials. Each author entry gives the publication title and the citation number. Report numbers, if applicable, are given in parentheses at the end of the entry. For publications with multiple authors, an author entry is provided for each. Entries for the second and succeeding authors give references to the first author.

Because of problems involved in the mechanical preparation of this index, all accent marks are omitted. Changes in spelling introduced as a result of accent omission follow standard conventions.

A

Aamodt, R.E., Nonlinear dynamics of drift-cyclotron instability, 3:27548
Aaron, R., *See* Kloet, W.M., 3:27227
Abad, J., *See* Barger, V., 3:27195
Abakumov, G.A., Laser based on yttrium—aluminum garnet with neodymium for generating a high-power fourth harmonic in the periodic pulse mode, 3:26758
Abbott, L.F., Possible supersymmetry breaking by pseudoparticles, 3:27244
Supercurrent anomaly in a supersymmetric gauge theory, 3:27243
Abdullaev, M.A., *See* Rustamov, M.I., 3:25774
Abegglen, C.E., Sea mammals: resources and population, 3:26938 (TID—26712, pp 493-510)
Abidova, M.F., *See* Kadyrova, G.I., 3:25775
Abraham, M.M., *See* Boldu O., J.L., 3:26631
See Chen, Y., 3:26596
Abramson, R., Installation for purifying the liquid metal used for cooling the core of a fast neutron reactor, 3:26287 (ANL-Trans—1113)
Abramyan, L.O., Asymmetry of the cross section of the photoproduction of eta mesons by polarized photons in the resonant energy region, 3:27105
Abshier, J.F., *See* McEldowney, R.C., 3:25910
Achenbach, J.D., *See* Weertman, J., 3:26106
Ackerman, J.P., Advanced fuel cell development. Progress report, July—September 1977, 3:26542 (ANL—77-79)
Adam, J., Eigenmode field structure of the fast magnetosonic wave in a Tokamak and loading impedance of coupling structures, 3:27428 (EUR-CEA-FC—886)
Adams, M.E., *See* LaMantia, C.R., 3:25678
Adams, O.C., Petroleum potential of southwestern Wyoming and adjacent areas, 3:25737
Adamyan, F.V., *See* Abramyan, L.O., 3:27105
Adler, S.L., Zeros of the Fredholm determinant for the external-field problem in Euclidean, massless spin-0 and spin-1/2 electrodynamics, 3:27266
Afanas'ev, Yu.V., Stationary model of the 'corona' of spherical laser targets, 3:27690
Agabekova, L.A., *See* Egiazarov, Yu.G., 3:25815
Agafonov, A.V., *See* Melik-Akhnazarov, T.Kh., 3:25778
See Radchenko, E.D., 3:25771
Agan'yants, A.O., *See* Abramyan, L.O., 3:27105
Agapova, A.V., *See* Kleimenov, N.G., 3:26174
Agarwala, U., Tracer experiments on the reaction of UH_3 in water, 3:26699 (AD—239162)
Agerup, C.C., *See* Gundtoft, H.E., 3:26388
Aglitskii, E.V., Laser-produced dense plasma diagnostics based on spectra of hydrogen-like and helium-like multicharged ions, 3:27692
Agthe, G., FLEX: a code for calculating neutron flux microdistributions in lattices consisting of hexagonal fuel assemblies, 3:26346
Ahlers, R.H., Full-scale aircraft crash tests of modified jet fuel. Final report, July 1972—May 1974, 3:25796 (AD-A—043843)
Ahlstrom, H.G., Diagnosis of laser fusion targets, 3:27677 (UCRL—52000-77-8, pp 23-29)
Ahmad, I., *See* Smither, R.K., 3:27364
Aihara, S., *See* Matsumoto, A., 3:27656
Aikawa, Hiroshi, Detection of the position and cross-section of a tokamak plasma with magnetic probes, 3:27468 (JAERI-M—6931)
Aivazov, A.A., Thermal conductivity of indium: mercury amalgams, 3:26614
Aizen, Kh.K., Boiler for an 800 MW power block fired by Ekibastuz coal, 3:26165
See Sotnikov, I.A., 3:26164
Akasofu, S.I., Study of the magnetic field annihilation process in the magnetosphere and some applications (electric currents in the Trans-Alaska pipeline induced by auroral activity), 3:27045 (RLO/2229/T5—7)
Akimoto, T., *See* Tada, B., 3:25885
Akimov, Yu.I., Selection of tube spacings of gastight enclosures of convective shafts of high-capacity boiler units, 3:26161
Al'terkop, B.A., Nonlinear stage of parametric interaction of waves in an active medium, 3:27585
Alarid, J.E., *See* Marsh, S.F., 3:26665
Albright, C.H., Electron signals from heavy-lepton cascade decays, 3:27190
Albright, J.R., *See* Bogert, D., 3:27145
Albritton, J.R., Transport of long—mean-free-path electrons in laser-fusion plasmas, 3:27683
Alburger, D.E., Pair decay of the 7.65-MeV level of ^{12}C, 3:27330
Aldrich, R.G., *See* Pecora, L.M., 3:25685
Alekhnovich, A.N., Study of the slagging properties of Kuznetsk coal ash, 3:25675
Aleksandrovich, K.V., Determination of electron density from the self-reversed deuterium D/sub b/line, 3:27476
Alekseevskii, N.E., Investigation of the heat capacity and of the superconducting properties of the sulfide Mo_6NaS_8, 3:26655
Alexander, J.M., *See* Miller, J.M., 3:27379
Alfven, H., Electric currents in cosmic plasmas, 3:27029 (TRITA-EPP—77-14)
Ali, A.W., *See* Hammer, D.A., 3:27438
Aliev, E.A., *See* Kasimova, Sh.S., 3:25759
Aliev, V.S., *See* Rustamov, M.I., 3:25774
Alimuralov, Sh.E., *See* Gadzhi-Kasumov, A.S., 3:25817
Allain, A., Turnstile device for fuel unloading of nuclear reactors, 3:26288 (ANL-Trans—1112)
Allen, M.A., RF system for the PFP storage ring, 3:26812 (SLAC-PUB—1898)
Allen, M.L., *See* Spedding, P.L., 3:26055
Altemus, R., *See* Bubb, E., 3:27314
Amado, R.D., *See* Kloet, W.M., 3:27227
Amaldi, E., Psi production and high-mass electron-pair limit in pp collisions at square-roots=52 GeV, 3:27133
Amann, J.F., *See* Iversen, S., 3:27335
Amato, A.J., Wind effected redistribution of surface contamination. Final report, September 1972—August 1976, 3:26880 (ORO—4394-4)
Ambats, I., *See* Ward, C.E.W., 3:27142
Ambrus, Gy., Mixed-bed system with outer regeneration, 3:26373
Amelin, V.Z., Uragan-2 experimental thermonuclear device of stellarator type, 3:27606
Ames, H.S., Automation of the national water quality laboratories, U.S. Geological Survey 2: design concepts for achievement of automation objectives, 3:27017 (UCRL—52295(Pt.2))
Ames, W.F., Some ad-hoc techniques for nonlinear partial differential equations, 3:27420
Amiraslanov, T.S., Experience of application of multidimensional regression analysis in connection with integrated interpretation of local gravitational anomalies of structurally

complex regions of Azerbaiian, 3:25742
Amos, D.E., *See* Nunziato, J.W., 3:26847
Amundsen, C.C., Terrestrial plant ecology, 3:26902 (TID—26712, pp 203-226)
An, L.Y., *See* Butt, E.P., 3:27631
An, S., *See* Kasai, M., 3:27697
Anastasia, L.J., Environmental aspects of the HYGAS Process, 3:25624 (CONF-780305—10)
Anbar, M., *See* Scolnick, M.E., 3:25800
Anderson, C.J., *See* Girnius, R.J., 3:27068
Anderson, D.E., Line focus segmented mirror concentrator, 3:26076
See Graf, D.L., 3:26115
Anderson, E.M., Improvement of the mechanical reliability of monolithic refractory linings for coal gasification process vessels. Bimonthly letter progress report, October—November 1977, 3:25630 (FE—2218-15)
Anderson, E.W., *See* Whitmore, J., 3:27139
Anderson, L., *See* Nagamiya, S., 3:27332
Anderson, L.W., *See* Girnius, R.J., 3:27068
Anderson, M., PEP main ring magnet system, 3:26814 (SLAC-PUB—2045)
Anderson, N.C., K-RB laser pump lamp. Final technical report Nov 73—Feb 75, 3:26734 (AD-B—009019)
Anderson, O.L., Temperature gradient of the upper mantle determined by the inversion of seismic data (abstract), 3:26111
Anderson, P.J., *See* Seay, J.G., 3:25856
Anderson, R., *See* Russell, O.R., 3:26921
Anderson, S.J., *See* Barreto, F., 3:25662
Anderson, T.D., Value of energy storage for direct-replacement solar thermal power plants, 3:26032 (CONF-780216—2)
Anderson, W.M., *See* Kursh, S.J., 3:26053
Andreev, M.F., Fission of ^{240}U in the reaction ^{238}U(t,pf), 3:27385
Andreev, V.N., Thermal-neutron fission of ^{233}U and ^{235}U accompanied by emission of α particles at small angles to the fission axis, 3:27384
Andreev, Y.M., Solar neutrinos and the role of exchange currents in the pp reaction, 3:27233
Andreeva, K.S., *See* Zinger, N.M., 3:26547
Andrianova, V.G., *See* Petukhov, V.A., 3:26618
Andryushin, V.M., *See* Kleimenov, N.G., 3:26174
Anfimov, V.A., *See* Swmylina, I.A., 3:25970
Angelopulo, O.K., Investigation of the cake formation process under static filtration conditions, 3:25757
Anon, Ekofisk-Emden gas pipeline, 3:25864
Ansorge, R.E., *See* Raja, R., 3:27128
Antonov, N.M., *See* Polynovskii, Ya.L., 3:26159
Aoyama, T., *See* Ichikawa, Y.H., 3:27565
Apostolakis, G.E., *See* Salem, S.L., 3:26472
Appelquist, T., Gauge fields and strong interactions, 3:27212
Apt, K.E., *See* Maeck, W.J., 3:25903
Arakawa, E.T., *See* Callcott, T., 3:26607
Archambault, C., Comparative temperature measurements on Mount Etna lavas: problems and techniques, 3:26088
Aristov, A.V., Correspondence between the calculated and experimental generated power of flashtube-pumped rhodamine lasers, 3:26748
Arkhangel'skii, N.V., *See* Goncharov, V.V., 3:26428
Armaganyan, A.A., *See* Abramyan, L.O., 3:27105
Armstrong, R.H., Weather and climate, 3:26897 (TID—26712, pp 53-58)
Arnaud, G., *See* Delpeyroux, P., 3:26304
Arthur, E.D., *See* Veeser, L.R., 3:27353
Artiles, A.F., Hybrid vehicle simulation program (Rev. 1), 3:26582 (COO/2835—1)
Asahara, K., *See* Ozaki, K., 3:25618
Asatryan, G.M., Many-particle Regge poles in supersymmetric theory, 3:27239
Asch, L., *See* Dattagupta, S., 3:26653
Ashare, E., Economics of carbon dioxide removal, 3:26019 (COO/2991—19, pp 119-130)
Ashcroft, D.J., Nuclear reactor, 3:26225
Asperger, R.G., *See* Martin, C.W., 3:25768
Attari, A., Fate of trace and minor constituents of coal during gasification. Final task report, 3:25641 (PB—270913)
Attenberger, S.E., *See* Peng, Y.K.M., 3:27637
Au, F.H.F., Influence of microbial activities on availability and biotransport of plutonium, 3:26916 (NVO—171, pp 219-226)
Auerbach, E.H., Surface transparent potentials: forward angle transfer and backward angle elastic scattering in heavy-ion collisions, 3:27338 (BNL—23461)
Auerbach, S.P., Classical diffusion in the presence of an X point, 3:27638 (PPPL-EPRI—7)
Avakyan, R.O., *See* Abramyan, L.O., 3:27105
Avci, H.I., Comparison of liquid ISSECs; Li, Pb, and Pb_4Li for use in laser fusion reactors, 3:27620 (UWFDM—208)
Effect of a liquid ISSEC on radiation damage parameters in laser fusion reactor first walls, 3:27619 (UWFDM—205)
Use and performance of graphite and metal ISSECs in tokamak fusion reactors, 3:27618 (UWFDM—202)
Averback, R.S., Radiation-annealing effects in energetic displacement cascades, 3:26628
Avias, J., Attempted geothermometric determination of maxima subsurface water temperatures of main hydrothermic areas of Languedoc—Roussillon and Pyrenees-Orientales, 3:26101
Avignone, F.T. III, *See* Cole, J.D., 3:27370
Avrekh, G.I., *See* Taber, A.M., 3:25792
Avrutskii, G.D., Investigation of cooling-down conditions of the K-200-130 turbine of a drum boiler-type power block, 3:26172
Ayers, R., *See* Clark, R., 3:26936
Azumi, M., *See* Imai, T., 3:27566
See Momota, H., 3:27433

B

Baaquie, B.E., (2 + 1) -dimensional Abelian lattice gauge theory, 3:27268
Gauge fixing and mass renormalization in the lattice gauge theory, 3:27281
Baba, K., *See* Ogawa, K., 3:26095
Babin, S.A., *See* Shul'man, I.E., 3:26183
Baca, P.M., *See* Granoff, B., 3:25663
See Thomas, M.G., 3:25664
Bache, T.C., Theoretical body and surface wave magnitudes for twelve numerically simulated cratering explosions. Topical report, 3:26850 (AD-A—043387)
See Lambert, D.G., 3:26865
Bachmann, K.J., *See* Shay, J.L., 3:26002
Backhaus, H.W., LNG offshore handling, 3:25841
Bacon, M.P., *See* Spencer, D.W., 3:26930
Badenhorst, G.P., *See* Barnes, V.C., 3:25724
Baembitov, F.G., Use of gamma—gamma logging in the operation of underground reservoirs for gas and petroleum products in rock salt deposits, 3:25823 (UCRL-Trans—11314)
Bagdasarov, Kh.S., *See* Abakumov, G.A., 3:26758
Bagley, K.Q., UK irradiation experience relevant to advanced carbide fuel concepts for LMFBR's, 3:26307
Bain, R.L., *See* Gary, J.H., 3:25665
Bainbridge, G.R., Advanced gas-cooled reactor has good energy prospects, 3:26256
Bair, W.G., *See* Anastasia, L.J., 3:25624
Baker, D.A., Population dose commitments due to radioactive releases from nuclear power plant sites in 1975, 3:26992 (PNL—2439)
Baker, L., Stability of ablation and combustion fronts, 3:27089
Baker, M., *See* Barker, T.G., 3:26864
Bakulenko, B.F., *See* Polynovskii, Ya.L., 3:26159
Balaban, T., Alternative approach to constructive lambdaPHI$_4^4$ quantum field theory, 3:27308
Balazs, L.A.P., Generation of a Pomeron and an f Regge pole in the dual-unitarization program, 3:27209
Balcomb, J.D., Facts and figuring: sizing collectors for space heating, 3:26052
Solar energy research, 3:26049 (LA—6807-PR, pp 34-48)
Bald, M., Impact on the employment situation of the construction and operation of power plants, 3:26500
Baldis, H.A., *See* Grek, B., 3:27686
Baldwin, R., *See* Gary, J.H., 3:25665
Ball, S.J., High-temperature gas-cooled reactor safety studies for the Division of Reactor Safety Research. Quarterly progress report, July 1—September 30, 1977, 3:26255 (ORNL/NUREG/TM—164)
Ballagh, H.C., Observation of μe events in anti ν and ν interactions in neon, 3:27114
Ballance, W.C., *See* Dudley, W.W. Jr., 3:26896
Baltz, A.J., Long-range absorption in the heavy-ion optical potential, 3:27369
See Auerbach, E.H., 3:27338
Band, Y.B., Design of natural collision coordinates to describe dissociation of polyatomic molecules, 3:27067
Bannik, B.P., Search for a new short-lived particle in collisions of 70 GeV/c protons with emulsion nuclei, 3:27118
Barabanov, N.L., *See* Mukhina, T.N., 3:25791
Barbaro-Galtieri, A., *See* Scharre, D.L., 3:27113
Barber, G.C., *See* Stewart, L.D., 3:27663
Barber, W.C., *See* Euteneuer, H., 3:27343
Barber, W.H., *See* Bowen, R.E., 3:26727
Barbieri, R., Hadrons (usual and newly discovered) in gauge theories a dream, 3:27213
Barbry, H., *See* Sitt, B., 3:27667
Barclay, A.G., Safety considerations for application of process stream analyzers in petrochemical plants, 3:25794
Bardet, R., Alumina-plasma interaction in the PETULA Tokamak, 3:27608 (CEA-CONF—3860)
Barefoot, E.D., *See* Pelletier, C.A., 3:26356
Barger, J.J., *See* Savor, D.E., 3:26379
Barger, V., Cascade decays of heavy leptons produced by neutrinos, 3:27195
Lifetimes and branching ratios for heavy-lepton cascades, 3:27188
Like-sign muon-electron production by neutrinos: Key to trilepton mechanisms, 3:27189
Barish, B.C., Measurements of ν/sub μ//sub N/and ν-bar/sub μ//sub N/charged-current total cross sections, 3:27115

Barish, S.J., Neutrino interactions in hydrogen and deuterium: Description of the experiment and study of the reaction $\nu + d \rightarrow \mu^- + p + p/sub\ s/$, 3:27116
Barker, T.G., Seismic studies for improved yield determination. Quarterly technical report, 1 January—31 March 1977, 3:26864 (AD-A—043389)
Barkhatov, L.S., *See* Shpil'rain, E.E., 3:26639
Barner, J.O., *See* Kerrisk, J.F., 3:26325
Barnes, P.D., *See* Roberson, P., 3:27130
Barnes, R.H., Laser spectroscopy for continuous combustion applications, 3:26700 (BMI—1982)
Barnes, V.C., Precautionary measures to reduce the probability of incipient heatings in coal mines, their early detection and safety procedures in dealing with colliery fires, 3:25724
Barnes, V.E., *See* Barish, S.J., 3:27116
See Whitmore, J., 3:27139
Barnett, D., Ultrastructure of Babesia equi and the parasitized equine erythrocyte, 3:26981 (CONF-770504—, pp 166-171)
Barnett, R.M., Distinguishing scaling violations from new currents, 3:27194
Search for heavy particles, 3:27184 (SLAC-PUB—1891)
Barr, W.L., Experimental and computational results on direct energy conversion for mirror fusion reactors, 3:27666
See Moir, R.W., 3:27602
Barreto, F., Three-phase flow characteristics of cylindrical vessels, 3:25662 (ORNL/MIT—257)
Barretto, P.M.C., *See* Smith, A.Y., 3:25922
Barrnett, R.J., Membrane biogenesis: an application of biochemistry and cytochemistry to electron microscopy, 3:26953 (CONF-770504—, pp 24-35)
Bart, G.R., Free field theories of spin-mass trajectories and quantum electrodynamics in the null plane, 3:27241
Barter, J.D., Ion cyclotron resonance heating in the Wisconsin supported toroidal octupole, 3:27450
Barth, J., Solubility of plutonium and americium-241 from rumen contents of cattle grazing on plutonium-contaminated desert vegetation in in vitro bovine gastrointestinal fluids, November 1974—May 1975, 3:26914 (NVO—171, pp 121-192)
Barthold, W.P., Assumptions, constraints and methodology of ANL advanced fuels system studies, 3:26322
Bartholdi, M., Single-particle light-scattering measurements with a photodiode array, 3:26823
Bartlett, D.F., Is an electron's charge independent of its velocity, 3:27150
Spinning magnets and Jehle's model of the electron, 3:27258
Bartlett, J.F., *See* Barish, B.C., 3:27115
Bartsch, R.R., Plasma stabilization requirements of the reference theta-pinch reactor (RTPR), 3:27540 (EUR—5602, pp 411-422)
Bartuska, V.J., Prospects for carbon-13 nuclear magnetic resonance analysis of solid fossil-fuel materials, 3:25668
Barut, A.O., Relativistic composite systems and extensible models of fields and particles, 3:27166
Basdevant, J.L., *See* Levy, M., 3:27292
Basehore, K.L., Analysis of the thermal-hydraulic behavior in the CRBR secondary control assembly, including interassembly heat transfer effects, 3:26405 (COO—2245-47TR)
Bashkirov, A.N., *See* Rozovskii, A.Ya., 3:25967
Basov, N.G., Investigation of compression of hollow microspheres irradiated by a laser, 3:27689
Power lasers for thermonuclear fusion, 3:27688
Basov, V.A., *See* Melik-Akhnazarov, T.Kh., 3:25778
Basov, Yu.G., Effect of discharge buildup in flash lamps on the efficiency of laser pumping, 3:26754
Bass, M., *See* Marburger, J.H., 3:26725
Bassani, P., Seismic drill hole surface plug, 3:26713
Basu, B., Moment equations treatment of the reconnecting mode, 3:27553
Basu, P., Burning rate of carbon in fluidized beds, 3:25716
Batenin, V.M., Scattering of argon laser radiation for low-temperature plasma diagnostics, 3:27475
Batey, J., Brookhaven National Laboratory Burner-Boiler/Furnace Efficiency Test Project. Hydronic equipment findings report reference manual, 3:26777 (BNL—50644)
Batey, W., *See* Bagley, K.Q., 3:26307
See Swanson, K.M., 3:26300
Batkin, A.R., Financing aspects of LNG trade, 3:25853
Batter, T.R., Study of the fermentation of xylose to ethanol by fusarium oxysporum, 3:26022 (LBL—6351)
Batusov, Y.A., Charged-particle emission accompanying muon capture by nuclei, 3:27396
Bau, R., *See* Teo, B.K., 3:26675
Bauer, A.A., Mixed-nitride fuel performance in EBR-II, 3:26306
Baum, J.J., *See* Varma, M.N., 3:27057
Baumeister, P., Comparison of solar photothermal coatings, 3:26071
Bautovich, G.J., *See* Genant, H.K., 3:26972
Baylon, D., *See* Reichmuth, H.S., 3:26014
Bazant, Z.P., *See* Weertman, J., 3:26106
Beachly, N.H., Increased fuel economy in transportation systems by use of energy management: third year's program. Final report, 1 May—1 July 1976, 3:26583 (PB—269607)
Beam, J.E., Evaluation of eutectic fluoride thermal energy storage unit compatibility. II. Test procedures and post-test evaluation results. Interim technical report, October 1975—June 1976, 3:26482 (AD-A—042234)
Bearg, D., *See* Murphy, B., 3:26193
Beauchamp, J.L., *See* Woodin, R.L., 3:26673
Beaudry, R. Jr, Fort Knox regional energy survey. Final report, 3:26511 (AD-A—042456)
Bebek, C.J., Electroproduction of inclusive pions at high Q^2, 3:27104
Becchi, C., Renormalization of gauge fields models, 3:27296
Becherer, R., Water cooled extraction grids, 3:27654 (EUR—5602, pp 857-861)
Becker, G., Free-boundary equilibrium computations for strongly elongated Belt Pinch plasmas, 3:27519
Becker, J.A., *See* Fisher, T.R., 3:27375
Beckert, W.F., *See* Au, F.H.F., 3:26916
Beeson, J.L., *See* Duncan, D.A., 3:25656
Beggs, H.G., Interpretation of seismic reflection data from the central South Park basin, Colorado, 3:25732
Belavin, A.A., Multidimensional method of the inverse scattering problem and duality equations for the Yang-Mills field, 3:27285
Bell, R.A., *See* Anderson, M., 3:26814
Bellamy, R.G., Irradiation performance analysis of UK fast reactor fuel, 3:26317
Bellus, F., Controlling the hazards from LNG spills on ground LNG fire fighting methods, 3:25842
Tests at the FOS terminal on the LNG behavior in the big tanks, 3:25888
Belyakov, Yu.S., Characteristics of fault locating instruments, 3:26199
Bemrick, B., *See* Pohlenz, J., 3:26975
Ben-David, S., Impacts of the national energy programme on solar economics, 3:26051 (LA-UR—78-131)
See Roach, F., 3:25985
Bender, C.F., *See* Rescigno, T.N., 3:27084
Bender, C.M., Path integral formulation of mean-field perturbation theory, 3:27272
Bender, D.J., *See* Moir, R.W., 3:27602
Benedek, S., Computer code for nuclear reactor core thermal transients, 3:26446
Beneventano, M., *See* Amaldi, E., 3:27133
Benkovitz, C.M., Using system 2000 with proposed ANSI standards for data exchange, 3:27717 (LA-UR—77-2739)
Benn, A.W., Sunningdale seminar on nuclear policy: a summary of the discussions, 3:26333
Bennett, L.L., *See* Meckoni, V., 3:25955
Bennett, W.W., Habitat requirements and population characteristics of the clapper rail (Rallus longirostris yumanesis) in the Imperial Valley of California, 3:26943 (UCRL—13813)
Benua, R.S., *See* Laughlin, J.S., 3:26971
Berdahl, C.M., *See* Reid, M.S., 3:25984
Bereiter, R., Prevention of fouling in waste-fired vessels, 3:26151 (AED-Conf—77-195-006)
Beresnevich, P.V., Movements of air flows in the working zones of excavators in open-pit mines, 3:25704 (LA-tr—78-6)
Berezin, A.B., *See* Burtsev, V.A., 3:27460
Berezin, I.A., *See* Aleksandrovich, K.V., 3:27476
Bereznai, T., Radioanalysis of water circuit at nuclear power plants, 3:26249
Berger, D., Effect of current peaking on non-circular uniaxial tokamak equilibria, 3:27520
Berger, E., LNG plants on floating structures: intermediate report on an extensive test program, 3:25870
Bergeron, R.J., *See* Nickerson, G.M., 3:26476
Bergman, R.G., *See* Kinney, R.J., 3:26676
Bergshtein, N.V., *See* Isaev, V.N., 3:25777
Berkner, K.H., Status of the LBL/LLL development program, 3:27658 (LBL—6830)
Berlad, A.L., *See* Batey, J., 3:26777
Berlizov, N.D., *See* Egerev, V.V., 3:25972
Berman, P.R., Theory of high intensity multimode gas lasers: inclusion of collisional effects. Final report, 15 August 1973—31 May 1977, 3:26714 (AD-A—042229)
Bernabei, S., Plasma-wave coupling and propagation using phased waveguide arrays, 3:27582
Bernadiner, M.G., Suction sticking of drilling tools, 3:25756
Bernard, C.W., Pseudoparticle parameters for arbitrary gauge groups, 3:27242
Bernard, M., *See* Bardet, R., 3:27608
Bernreuther, W., Classical solution of the Yang-Mills equations in Minkowski space, 3:27264
Bernstein, E.R., Optical and zero field magnetic resonance spectroscopy of inorganic molecular solids. Final report, 1 June 1975—31 May 1977, 3:26645 (AD-A—043340)
Bernstein, I.B., *See* Albritton, J.R., 3:27683
Bernstein, S.E., *See* Russell, E.S., 3:26987
Berry, H.G., Production of orientation and alignment in heavy-ion—surface collisions, 3:27078
See Hight, R.D., 3:27075
Bertolini, E., JET power supply comprehensive system, 3:27646 (EUR—5602, pp 741-746)

Plasma power balance models for self-sustained tokamak reactors, 3:27624
Beruto, D., *See* Searcy, A.W., 3:26672
Besmann, T.M., Chemical thermodynamics of the system Cs—U—Zr—H—I—O in the LWR fuel-clad gap, 3:26211 (ORNL/TM—6130)
Best, F.R., Analysis of nuclear and coal fueled total energy system options for Fort Knox, Kentucky. Final technical report, June 1976—June 1977, 3:26338 (AD-A—043701)
Best, H., Rotation-symmetrical container with insulating cover, 3:26366
Betancourt, O.L., *See* Talmadge, J.N., 3:27528
Bevilacqua, F., Applying improved instrumentation and computer control systems, 3:26406
C-E balances the benefits against the costs, 3:26236
System 80 NSSS combines proven and new features, 3:26233
Bezdek, R.H., Summary of proceedings of solar heating and cooling commercialization workshop, 3:26047 (DSE/4017—1)
Bhadra, D.K., Anomalous interaction of alpha particles with the dissipative trapped-ion mode, 3:27554
Bhattacharyya, T.K., Solar dryingin thin layers, 3:26058
Bialynicka-Birula, Z., Coherent dynamics of N-level atoms and molecules. II. Analytic solutions, 3:27086
See Eberly, J.H., 3:27085
Bialynicki-Birula, I., Charge conservation and gauge invariance, 3:27303
See Bialynicka-Birula, Z., 3:27086
See Eberly, J.H., 3:27085
Biancheria, A., *See* Cox, C.M., 3:26303
See Nayak, U.P., 3:26319
See Stephen, J.D., 3:26320
Bibby, D.M., Composition and variation of pulverized fuel ash obtained from the combustion of sub-bituminous coals, New Zealand, 3:25673
Bickle, L., *See* Roach, F., 3:25985
Biel, J., *See* Mollet, W., 3:27123
Bierney, T.K., Instrumentation for the measurement of vibration in severe environments, such as nuclear reactors, 3:26374
Bijl, P., LNG peak-shaving plant at Maasvlakte, 3:25852
Bild, E.M., *See* Vasalos, I.A., 3:25659
Billone, M.C., Progress in modeling carbide and nitride fuel performance in advanced LMFBRs, 3:26318
See Stephen, J.D., 3:26320
Bills, D., *See* Kroopnick, P.M., 3:26100
Bingham, C.R., *See* Cole, J.D., 3:27370
Bingham, H.H., *See* Ballagh, H.C., 3:27114
Bingman, R., Analysis of design changes necessary to adapt receiver to compound parabolic reflector. Final report, 3:26059 (ANL-K—3805-1)
Binkley, M., *See* Lys, J.E.A., 3:27126
Birgeneau, R.J., *See* Tarvin, J.A., 3:26603
Birman, A.Y., Competition of oppositely traveling waves in a single-isotope ring laser with anisotropic cavity, 3:26747
Biryukov, N.S., Equilibrium, pre-equilibrium, and direct processes in the (n,n′) reaction, 3:27354
Biryukov, O.V., *See* Amelin, V.Z., 3:27606
Bischoff, J.L., *See* Shanks, W.C. III, 3:26120
Bishop, J.F.W., UK strategy and programmes for advanced LMFBR fuels, 3:26294
Bishop, J.M., *See* Biswas, N.N., 3:27132
Biswas, N.N., Inclusive Δ^{++} (1232) production in 200-GeV/c π^- p interactions, 3:27132
Bityurin, V.A., Two-dimensional electrical effects in a frame-type MHD channel, 3:26537
Bizli, K.O., Alfven short-wave excitation by high-energy ions in a tokamak, 3:27562 (IAE—2552)
Bjoernsson, H., Explanation of Joekulhlaups from Grimsvoetn, Vatnajoekull, Iceland, 3:26090
Bjorken, J.D., High transverse momentum hadron-hadron collisions, 3:27214
Summary talk: neutrino '77, 3:27111 (SLAC-PUB—1996)
Black, S.A., Powdered metal source for production of heat and hydrogen gas, 3:25958
Blackmon, D.B., Selecting sites for ease of licensing requirements, 3:26414
Blais, P.D., *See* Hopkins, R.H., 3:25990
Blake, G., *See* Ashcroft, D.J., 3:26225
Blank, H., Correlation between properties and irradiation behavior for carbide, carbonitride and nitride fuels, 3:26316
Blaser, E., *See* Chaney, D., 3:27121
See Mollet, W., 3:27123
Blevins, M.L., *See* Savor, D.E., 3:26379
Blewett, P., *See* Cooper, F., 3:27087
Bliss, W.A., Plutonium distribution in the environs of the Nevada Test Site: status report, 3:26911 (NVO—171, pp 227-236)
Bobodzhanov, I., *See* Bannik, B.P., 3:27118
Bodek, A., *See* Barish, B.C., 3:27115
Bodizs, D., *See* Bereznai, T., 3:26249
Boduszynski, M., Investigations on Romashkino asphaltic bitumen. III. Fractionation of asphaltenes using ion-exchange chromatography, 3:25781
Boehm, A., Quantum mechanics in particle physics, 3:27202
Boehm, F., *See* Cheung, N.K., 3:27348
Bogatkin, V.I., *See* Nekrasov, V.G., 3:26167
Bogert, D., Inclusive production of neutral strange particles in 250-GeV/c π^- p interactions, 3:27145
Bogomaz, V.N., *See* Livshits, M.A., 3:26176
Bogomolov, V.V., *See* Alekhnovich, A.N., 3:25675
Bogy, D.B., Use of one-dimensional Cosserat theory to study instability in a viscous liquid jet, 3:27088
Boiarski, A.A., *See* Barnes, R.H., 3:26700
Boiko, V.A., *See* Aglitskii, E.V., 3:27692
Boldu O., J.L., Electron-nuclear double resonance of V/sub OD/ defects in SrO, 3:26631
Bolduc, R.L., *See* Biswas, N.N., 3:27132
Boley, C.C., Effect of charge preheat on the physical quality of coke from three Western coals, 3:25617 (GFERC/RI—77/3)
Bolle, D., *See* Tandy, P.C., 3:27394
Boltax, A., *See* Nayak, U.P., 3:26319
Bombi, F., Command interpreter for the Padua data acquisition system, 3:27693 (EUR—5602, pp 499-504)
Bonczyk, P.A., *See* Eckbreth, A.C., 3:26701
Bond, P.D., *See* Kovar, D.G., 3:27341
Bondar, I.E., *See* Egerev, V.V., 3:25972
Bondar, Yu.F., *See* Maklakova, V.P., 3:26158
Bonfiglioli, G., Situation of LNG in Europe, 3:25849
Bonnaure, C., *See* Bellus, F., 3:25888
Bonnel, P., Description of the fast moving limiter used with T.F.R., 3:27612 (EUR-CEA-FC—893)
Bonner, B.P., *See* Dengler, L.A., 3:26119
Book, D.L., Stabilized imploding liner fusion systems, 3:27600
Booth, R., Rotating target neutron generators, 3:26789
See Logan, C.M., 3:26798
Boozer, A.M., *See* Auerbach, S.P., 3:27638
Borchardt, S.R., etaeta′ and ωphi mixing in the nonrelativistic quark model, 3:27179
Boreskov, K.G., Photoproduction of J/psi mesons in the peripheral model. The direct peripheral mechanism, 3:27181
Borgia, B., *See* Amaldi, E., 3:27133
Boridy, E., Elastic scattering of 1-GeV protons by nuclei, 3:27127
Borisov, G.M., Experimental investigation of the effect of regime factors on the economic efficiency of the TP-230B boiler simultaneously burning anthracite fines and residual oil, 3:26170
Obtaining thermal experimental multifactorial analytical characteristics of turbo-sets by utilizing the experiment planning method, 3:26175
See Kalafati, D.D., 3:26162
Borod'ko, V.Ya., *See* Beresnevich, P.V., 3:25704
Borozdin, V.S., Measurement of the cross sections of copper atoms for excitation by electron impact, 3:27082
Borukhovich, A.S., *See* Korshunov, I.G., 3:26615
Bos, P.B., *See* DeMeo, E.A., 3:26029
Bosetti, P., *See* Ballagh, H.C., 3:27114
Bosholm, J., Effects on the activity level in the primary circuit water coolant of pressurized water reactors by continuous purification of partial streams, 3:26231
Bosler, G.E., *See* Seed, T.J., 3:27616
Bostick, W.H., Space-time structure of neutron and X-ray sources in a plasma focus, 3:27483
Boswell, J., *See* Comiso, J.C., 3:27333
Boudrie, R., *See* Iversen, S., 3:27335
Bourgeois, N.A. Jr., Software development of a real time signal processing system, 3:27707 (SAND—77-1684C)
Bourrier, P., Three-dimensional calculations for the JET mechanical structure, 3:27694 (EUR—5602, pp 275-279)
Bowen, J.C., Error analysis of solar collector performance data, 3:26073
Bowen, R.E., Solid gas generators for chemical lasers, 3:26727 (AD-A—042674)
Bowers, C.H., *See* Mync, L., 3:26475
Bowers, W.M., *See* Laird, R.A., 3:26284
Bowie, W.H., *See* Zuclich, J.A., 3:26999
Bowles, T., Properties of inclusive (π^+,π^0) reactions in nuclei, 3:27334
Bowman, H., *See* Flower, M.F.J., 3:27009
Bowman, M.G., Status of European thermochemical hydrogen programs, 3:25959 (LA-UR—77-2985)
Boyarshinov, V.V., *See* Koroteev, A.S., 3:27534
Boyer, J.F. Jr., Evaluation of the effects of coal cleaning on fugitive elements. January 1, 1977—August 31, 1977, 3:25707 (COO/4427—1)
Boyer, K., *See* Iversen, S., 3:27335
Boyle, M.J., *See* Haas, R.A., 3:27448
Bradford, P., *See* Bowen, J.C., 3:26073
Bradley, W.G., *See* Moor, K.S., 3:26915
Braithwaite, W.J., *See* Iversen, S., 3:27335
Brambilla, M., *See* Bernabei, S., 3:27582
Bramson, P.E., *See* Glenn, R.D., 3:26826
Brandon, J.R., Thermoradiation treats sewage sludge, 3:26576
Brandt, H., *See* Pitts, J.H., 3:26857
Bratton, T., *See* Cocke, C.L., 3:27070
Braun, R., Where does the garbage go, 3:26575 (DOE-tr—26)
Braunschweig, E.D., Free expansion nozzle for gas dynamic lasers, 3:26753
Brayman, K.W., *See* Smith, B.A., 3:26394
Brayman, K.W. George, D.K., Spacer for nuclear reactor fuel rods, 3:26398
Brechbill, R.A., Status of the Norway rat, 3:26904 (TID—26712, pp 261-267)
Brecht, S.H., Parametric dependence of the ion cyclotron instability in a two-energy-component system, 3:27545
Breland, M., *See* Galichon, P., 3:25914
Brenchley, D.L., Assessment methodology for chemical effluents, 3:26874 (BNWL—2219, pp 31-48)

Environmental assessment methodology for the nuclear fuel cycle, 3:26873 (BNWL—2219)
Brenner-Tourtelot, E.F., *See* Vine, J.D., 3:27020
Bretfeld, H., Application of acoustic emission analysis during loading of a pressure vessel by pulsating internal pressure, 3:26360
Bretz, N., Multichannel Thomson scattering apparatus, 3:27472
Brewer, P.G., *See* Spencer, D.W., 3:26930
Briefel, E., Search for Ξ^* production in K^-p interactions at 2.87 GeV/c, 3:27140
Briffod, G., *See* Bardet, R., 3:27608
Briscoe, H., Interim report on phase I expansion of the seismic communication and control processor system (CCP). Technical report, 30 June—31 December 1976, 3:26862 (AD-A—042632)
Brittingham, J.N., Bivariate interpolation approach for efficiently and accurately modelling antennas near a halfspace, 3:26776
Broch, M., Commissioning of a nuclear power plant, 3:26248
Brocklebank, R.B., *See* Ashcroft, D.J., 3:26225
Brockway, M.C., *See* Schorr, J.R., 3:26882
Broda, R., *See* Hrynkiewicz, A., 3:27316
Brodsky, S.J., Constituent models and large transverse momentum reactions, 3:27107 (SLAC-PUB—1733)
Impact of quantum electrodynamics, 3:27255 (SLAC-PUB—1699)
Large transverse momentum phenomena, 3:27205 (SLAC-PUB—2009)
Recent developments in the theory of large transverse momentum processes, 3:27119 (SLAC-PUB—1806)
Retention of quantum numbers by quark and multiquark jets, 3:27159
Brody, A., *See* Lys, J.E.A., 3:27126
Broglia, R.A., Hydrodynamics of Fermi superfluids, 3:27096
Brookins, D.G., Iotopic evidence for local derivation of strontium in deep-seated, fracture-filling calcite from granitic rocks in drill hole GT-2, Los Alamos Scientific Laboratory Dry Hot Rock Program, 3:26103
Uranium abundance in some Precambrian and Phanerozoic rocks from New Mexico, 3:25912
Uranium deposits of the Grants mineral belt: geochemical constraints on origin, 3:25911
Brough, W.G., *See* Shay, W.M., 3:26444
Brow, D., *See* Spedding, P.L., 3:26055
Browman, A., *See* Bebek, C.J., 3:27104
Brown, Genetic selection, physiological basis of vigor, tissue culture, 3:26024 (SRO—0888-2, pp 2-11)
Brown, C.N., *See* Bebek, C.J., 3:27104
Brown, D., *See* Clark, R., 3:26936
Brown, D.P., Time required to replace an ISABELLE ring magnet, 3:26808 (BNL—23536)
Brown, G.G., *See* Suleiman, S.A., 3:26980
Brown, K.W., *See* Barish, B.C., 3:27115
Brown, M.M., Literature survey of bacterial, fungal, and Drosophila assay systems used in the evaluation of selected chemical compounds for mutagenic activity, 3:26994 (ORNL/EMIC—9)
Brown, P.L., *See* Butler, D., 3:26092
Brown, R.E., *See* Haglund, R.F. Jr., 3:27324
Brown, R.J., Acid mine drainage (a bibliography with abstracts). Report for 1964-Nov 77, 3:26931 (NTIS/PS—77/0949)
Brown, T., *See* Goldston, R.J., 3:27592
Brown, W.W., Method for removing radioactive corrosion products from the inner surfaces of a nuclear reactor, 3:26378
Bruce, A.D., Single-particle properties of systems undergoing structural phase transitions, 3:26638
Brueckner, K.A., Fast-electron production in laser-heated plasmas, 3:27477
Production of fast ions in laser-heated plasmas, 3:27459
Brueckner, W., *See* Nagamiya, S., 3:27332
Bruzzone, H., Some properties of the neutron yield in a low-energy plasma focus, 3:27493
See Vargas, M., 3:27485
Bryant, H.C., *See* Gram, P.A.M., 3:27058
Bubb, E., Target cooling (Bates Linac), 3:27314 (ORO—4043-37, pp 26-29)
See McCarthy, J., 3:27377
Bubenzer, O., Vapor separator for a nuclear reactor plant, 3:26372
Buccella, F., Quarks, 3:27165
Buchholz, D., *See* Barish, B.C., 3:27115
Buchlin, J.M., Hot spots in active packed beds, 3:26257
Buck, D.I., Procedural tip for intestine sections, 3:26958 (CONF-770504—, pp 176)
Buckner, M.R., Jeremiah environmental computational system, 3:26887 (DP-MS—77-41)
Buddemeier, R.W., *See* Kroopnick, P.M., 3:26100
Budini, P., Composite gauge fields and models, 3:27203
Budny, R., Can couplings of charged heavy leptons to the W^0 be measured, 3:27174
Buehler, E., *See* Shay, J.L., 3:26002
Bugaev, E.V., *See* Andreev, Y.M., 3:27233
Bugrov, V.N., Measurement of the effective widths of excited states of heavy nuclei (Z=98, 100, 102) by means of the blocking effect, 3:27382
Bukharov, V.P., *See* Livshits, M.A., 3:26176
Bulgakov, B.M., Self-modulation of lasers by means of nonlinear absorbing filters, 3:26761
Bulgakov, V.G., Design development and experience of operation of a high-temperature residual oil preheater, 3:26185
Bunce, G., *See* Heller, K., 3:27129
Bunnell, K., *See* del Papa, C., 3:27102
Buntikova, A.F., *See* Petrosyan, R.V., 3:25906
Burak, Z.G., *See* Egiazarov, Yu.G., 3:25815
Burakhanov, B.M., *See* Bityurin, V.A., 3:26537
Burch, J., *See* Clark, R., 3:26936
Burd, W.C., Software documentation guidelines and procedures for Applicon systems, 3:27708 (SAND—77-1831)
Burdet, R., *See* Dawance, G., 3:26386
Burdick, G.R., Phases mission analysis: a review of new developments and an application, 3:26221
Burgess, J.H., *See* Tindale, J.B., 3:26392
Burgoyne, C.M., *See* de Almeida, A.A., 3:27591
Burgvits, G.A., Experience of operation and results of tests of TP-100 and TP-100A boilers with open-loop pulverized fuel systems designed by tckti, 3:26140
Burke, J.C., System definition study: Phase 1 of individual load center, solar heating and cooling residential project. Final report, 3:26048 (EPRI-ER—594)
Burkett, R.D., Limnology, 3:26923 (TID—26712, pp 269-286)
Burkhardt, W., Reactor coolant pump for a nuclear reactor, 3:26376
Burleson, G., *See* Iversen, S., 3:27335
Burleson, G.R., *See* Fisher, T.R., 3:27375
Burn, K., Neutron streaming problems in the 'FINTOR 1' design, 3:27609 (EUR—5602, pp 665-671)
Burnett, T.H., *See* Ballagh, H.C., 3:27114
BURNHAM, J., Transport properties of helium II in fine channels, 3:27095 (AD—239477)
Burns, D.J., *See* Yie, G.G., 3:26704
Burrell, K.H., *See* Waltz, R.E., 3:27630
Burrows, T.W., Panel on reference nuclear data and surveys of reference data requirements, 3:27313 (BNL-NCS—50717)
Bursak, A.V., Matrix elements in the method of angular potential functions, 3:27387
Bursian, N.R., Dehydrogenation of higher paraffins, 3:25793
Burton, L.C., *See* Haack, G., 3:25994
Burtsev, V.A., Heating a dense theta-pinch plasma with strong fast-rising magnetic fields, 3:27460
Burwell, C.C., Solar biomass energy: an overview of U.S. potential, 3:26027
Busby, H.R., *See* Trujillo, D.M., 3:26349
Busch, H., *See* Kluge, H., 3:26663
Bush, E.A., *See* Offman, P.E., 3:25727
Bush, T.W., Basic studies of coal pyrolysis and hydrogasification. Quarterly progress report, July 1, 1977—September 30, 1977, 3:25619 (FE-MIT—2295T26-3)
Bushnell, D.L., *See* Smither, R.K., 3:27364, 3:27372
Buskirk, F.R., Investigation of giant multipole resonances in medium and heavy nuclei by inelastic electron scattering. Final technical report, 15 October 1974—31 October 1976, 3:27356 (AD-A—042298)
Buslaev, V.S., *See* Goncharov, V.V., 3:26428
Bust, C.P., *See* Raja, R., 3:27128
Busza, W., *See* Halliwell, C., 3:27124
Butler, B.L., *See* Pettit, R.B., 3:26062
Butler, D., Seismological methods and the search for geothermal resources, 3:26092
Butler, P., New heat and power package is leaping over the final hurdle, 3:26188
Butt, E.P., Reversal of the toroidal magnetic field in pinches, 3:27631 (CLM-R—165)
Buttram, M., *See* Leeper, R.J., 3:27143
Butz, H.P., Safety of nuclear power plants, 3:26466
Buzankin, V.V., Magnetoacoustic-heating experiments in tokamak T-4 plasma, 3:27451
Buzanova, G.N., *See* Mukhlenov, I.P., 3:26668
Byer, R.L., Coherent anti-stokes Raman spectroscopy. Final report, 3:26669 (AD-A—042273)
Tunable optical sources. Final report 1 Jul 74—30 Jun 77, 3:26732 (AD-A—046004)
Byers, F.M. Jr., *See* Quinlivan, W.D., 3:27018
Bykov, M.M., *See* Bulgakov, B.M., 3:26761

C

Cachera, P.C., Process for the continuous control of the seal and strength of the containment of a reactor utilizing said process, 3:26289 (ANL-Trans—1111)
Cahn, R.N., New absolutely stable hadrons, 3:27149
Caldarola, L., Unavailability and failure intensity of components, 3:26362
Callan, C.G. Jr., Pseudoparticles and massless fermions in two dimensions, 3:27158

Callcott, T., Emission and absorption x-ray edges of Li, 3:26607
Callen, J.D., Drift-wave turbulence effects on magnetic structure and plasma transport in tokamaks, 3:27513
Callias, C.J., Spectra of fermions in monopole fields: Exactly soluble models, 3:27269
Calza-Bini, A., Mechanical behavior of a fuel pin for fast reactors: effect of the fuel form and of the approach-to-power on the change of the fuel stack length under irradiation, 3:26302
Camarda, H.S., High resolution neutron total cross section measurement of ^{89}Y, 3:27366
Cambel, A.B., *See* Bezdek, R.H., 3:26047
Cameron, J., *See* Smith, A.Y., 3:25922
Campbell, E.E., *See* Morales, R., 3:26997
Campbell, F.J., Connector hinge for oil containment booms, 3:25805
Campbell, J., *See* Barish, S.J., 3:27116
Campbell, J.H., Effects of underground coal gasification on ground-water quality, 3:25644 (UCRL—80145)
Campolunghi, F., Full scale tests and thermal design correlation for coiled once-through steam generators, 3:26184
Canali, U., *See* Burn, K., 3:27609
Canobbio, E., Heating of toroidal plasmas, 3:27426 (CEA-CONF—3863)
Canter, J., *See* Briefel, E., 3:27140
Cantley, D.A., *See* Chandler, J.C., 3:26321
Cantrell, E.L., Observation of propagating m=1 waves in Scyllac, 3:27583
Cantu G, M., Design of a homogeneous reactor for the manufacture of chloromethanes, 3:25782
Capener, H.R., *See* Jewell, W.J., 3:26010
Caracchini, R., *See* Calza-Bini, A., 3:26302
Carasso, A., System of nonlinear partial differential equations describing cylindrical plasma collapse, 3:27506 (LA—6824)
Carbajo, J.J., TECAR, a new program for LOCA analysis, 3:26448
Cardenas, R., *See* Gregor, H.P., 3:26009
Carli, G., *See* Burd, W.C., 3:27708
Carlin, J.T., Salinity tolerant surfactant oil recovery process, 3:25747
Carlson, G., *See* Hartman, C.W., 3:27604
Carmony, D.D., *See* Barish, S.J., 3:27116
See Whitmore, J., 3:27139
Carpenter, J.M., Pulsed spallation neutron sources for slow neutron scattering, 3:26790
Carr, D.L., Fiber-optic-coupled LOC injection-laser array for 8500 angstroms room-temperature emission. Final report, 3:26724 (AD-A—042490)
Carrie, C., *See* Dawance, G., 3:26386
Carroll, W.F., *See* Cuddihy, E.F., 3:25999
Carron, N.J., Description of the code SCALID for calculating the one dimensional SGEMP boundary layer. Topical report, 3:26833 (AD-A—043519)
Carter, H.K., *See* Cole, J.D., 3:27370
Carter, J.R., *See* Raja, R., 3:27128
Carter, W.J., Evaluation of methods for stimulation and characterzation of eastern gas shales. Progress report, April—June 1977, 3:25859 (LA—7094-PR)
Caruvana, A., Development of high temperature turbine subsystem technology to a "technology readiness status": Phase I. Quarterly report, January—March 1977. Preliminary draft, 3:26141 (FE—1806-20)
Casler, G.L., *See* Jewell, W.J., 3:26010
Cason, N.M., *See* Biswas, N.N., 3:27132
Caspersson, S.A., Optimization system design studies of advanced carbide fuel, 3:26323
Cataldo, D.A., Radionuclide transport, 3:25948 (PNL—2253, pp 5.1-5.14)
See Rogers, L.E., 3:25952
Cataldo, J.C., Phenomenological models for prediction of water temperatures due to thermal-electric power plant heated discharges. Final report, 3:26935 (PB—273468)
Catchen, G.L., *See* Miller, J.M., 3:27379
Catlin, R.J., *See* Meckoni, V., 3:25955
Catto, P.J., *See* Simon, A., 3:27538
See Tsang, K.T., 3:27445
Caughey, D.A., Accelerated iterative calculation of transonic nacelle flowfields, 3:27091
Cavaggion, C., *See* Bombi, F., 3:27693
Cavagnaro, D.M., Solid waste disposal economics (a bibliography with abstracts). Report for 1964—September 1977, 3:26574 (NTIS/PS—77/0790)
Waste processing and pollution in the chemical and petrochemical industries. Volume 2. 1975—August 1977 1977 (a bibliography with abstracts). Report for 1975—August 1977, 3:25797 (NTIS/PS—77/0706)
Cavallo, J.D., *See* Cohen, A.S., 3:26890
Cayol, D., *See* Broch, M., 3:26248
Cecchi, J.L., *See* Pegg, D.J., 3:27080
Cecchi, P., CNEN program on advanced LMFBR fuels, 3:26299
Cecil, A., ACT: an 8080 MACRO processor, 3:27710 (UCID—17722)
Ceglio, N.M., Micro-Fresnel zone plates for coded imaging applications, 3:27473
Cence, R.J., *See* Ballagh, H.C., 3:27114
Centeno, R., *See* Bonfiglioli, G., 3:25849
Cermak, V., Correlation of heat flow and crustal structure in Europe (abstract), 3:26112
Cerny, J., Initial results with the Berkeley on-line mass separator-RAMA, 3:26803 (LBL—7156)
Chadha, B.R., *See* Boduszynski, M., 3:25781
Chagrot, M., Case for fuel redesign after in pile safety experiments: the "COMMANDO" tests, 3:26315
Chakrygin, V.G., *See* Aizen, Kh.K., 3:26165
Challender, R.S., Accessibility and replacement as prime constraints in the design of large experimental Tokamaks, 3:27593 (EUR—5602, pp 447-452)
Chamberlain, A., *See* Bishop, J.F.W., 3:26294
Chamberlain, O., *See* Nagamiya, S., 3:27332
Chambers, L.E., Economics of naphthe versus gas cracking, 3:25831
Chancellor, R., Mesaverde hydraulic fracture stimulation, northern Piceance basin: progress report, 3:25860
Chandler, J.C., Development of LMFBR core designs using reference and advanced oxide fuel, 3:26321
Chaney, D., Inclusive charged-particle production in neutron-nucleus collisions, 3:27121
Chang, C.C., *See* Wu, J.R., 3:27327
Chang, C.Y., *See* Briefel, E., 3:27140
Chang, J., High resolution time resolvable flash x-radiography system, 3:27670 (SAND—77-1587C)
Chang, L.N., Dimuon distribution from production of heavy particles in high-energy ν and nu-bar reactions, 3:27187
Chang, S., Nonperturbative approach to infrared behavior for $(\mathrm{phi}^3)_6$ theory and a mechanism of confinement, 3:27155
Semiclassical infrared emission processes in the $(\mathrm{phi}^4)_4$ theory, 3:27152
Chang, V., Parton-picture unitary impact-parameter model for multicluster production, 3:27229
Chao, A.W., Quantum lifetime in electron storage rings, 3:26811 (SLAC-PUB—1884)
Chapin, D.L., Trade study analysis for TNS tokamaks, 3:27642 (WFPS-TME—056)
Chapman, L.D., Users guide for evaluating alternative fixed-site physical protection systems using "FESEM", 3:25954 (SAND—77-1367)
Charles, P.A., *See* Zarnecki, J.C., 3:27030
Charles, R.W., Reaction of granodiorite with water at 300°C and 1/3 kb in a circulation system (abstract), 3:26121
Charlton, G., *See* Barish, S.J., 3:27116
Chatterjee, N., Operational flexibility of LNG plants using the propane precooled multicomponent refrigerant MCR process, 3:25838
Chayanov, V.A., *See* Nekrasov, V.G., 3:26167
Cheadle, J.M. Jr., Data management and handling for the Hydrogeochemical and Stream Sediment Reconnaissance program at the Los Alamos Scientific Laboratory, 3:25907 (LA—7128-MS)
Cheblukov, Y.N., *See* Il'Ina, I.L., 3:27402
Chebotaev, P.Z., *See* Vekshtejn, G.E., 3:27458
Cheetham, A.K., Profile analysis of powder neutron diffraction data: its scope, limitations, and applications in solid state chemistry, 3:26680
Chekhovskoi, V.Y., *See* Petukhov, V.A., 3:26617, 3:26618
See Shestakov, E.N., 3:26619
Chen, H.H., Nonlinear wave and soliton propagation in media with arbitrary inhomogeneities, 3:27417
Chen, H.S., *See* Tarvin, J.A., 3:26603
Chen, J.C., *See* Levy, E.K., 3:25713
Chen, J.M., *See* Yang, R.T., 3:25710
Chen, K.I., *See* Terry, J.L., 3:27446
Chen, R.C., *See* Helbert, J.N., 3:26693
Chen, S.C.C., *See* Srour, J.R., 3:26836
Chen, S.H., Study of self-diffusion in dense hydrogen gas by quasielastic incoherent neutron scattering, 3:26592
Chen, T., Diverging solitons and their transition to dispersive waves, 3:27574
Mathematical modelling of coal combustion in fluidized beds with sulphur emission control by limestone or dolomite, 3:25717
Chen, Y., High-temperature and ionization-induced effects in lithium-doped MgO single crystals, 3:26596
See Boldu O., J.L., 3:26631
Chen, Y.F., Optimal power profile fuel management, 3:26250
Chen, Y.R., *See* Hashimoto, A.G., 3:26017
Cheng, D.Y., *See* Hartman, C.W., 3:27604
Cherkasov, A.S., *See* Aristov, A.V., 3:26748
Chernakova, G.N., *See* Melik-Akhnazarov, T.Kh., 3:25778
Chernigin, S.P., *See* Aizen, Kh.K., 3:26165
Chernyaev, V.S., *See* Korshunov, I.G., 3:26615
Chetverikov, V.A., *See* Shakhsuvarov, K.L.V., 3:26171
Cheung, N.K., Test of time reversal invariance in ^{57}Fe, 3:27348
Chevalier, L., *See* Bellus, F., 3:25888
Chiao, T.T., *See* Hamstad, M.A., 3:26708
Chien, C., *See* Gilchriese, M.G.D., 3:27138
Chieves, L., *See* Barnett, D., 3:26981
Ching, W.Y., Structural disorder and electronic properties of amorphous silicon, 3:26644
Chirkov, V.A., *See* Ilyukhin, A.A., 3:26749
Chisel, D.M., *See* Thomas, N.L., 3:25998
Chistyakov, O.D., *See* Nikitin, S.A., 3:26625
Chiu, C., WARD blanket assembly pre-test predictions by SUPERENERGY, 3:26281 (COO—2245-40TR)

Chiu, C.B., Predictions of variations of the speed of light measured by stable clocks, 3:27406
Chiu, K.Y., *See* Srour, J.R., 3:26836
Chiu, S., *See* Dobson, J.E., 3:26932
Chizhov, V.V., *See* Sherstyuk, A.N., 3:26163
Chlouber, C., Contribution to the eighth-order anomalous magnetic moment of the muon, 3:27173
Cho, Y., *See* Barish, S.J., 3:27116
Chodzko, R.A., *See* Turner, E.B., 3:26717, 3:26722
Chott, J.R., *See* Roe, J.M., 3:26834
Christ, N.H., *See* Bernard, C.W., 3:27242
Christ, R., Spacers for fuel elements with a large number of fuel rods, 3:26400
Christensen, D.L., Solar heating and cooling demonstration program contractor's review. Summary and analysis of workshop and panel sessions, 3:26044 (CONF-771229—(Summ.))
Christian, D.J., *See* Thorngate, J.H., 3:26829
Christian, R.S., *See* Whitmore, J., 3:27139
Christiansen, U., *See* Christ, R., 3:26400
Chu, C.K., *See* Park, W., 3:27526
Chu, K.R., Comparative study of the axial and azimuthal bunching mechanisms in electromagnetic cyclotron instabilities, 3:27546
Chu, S.L., *See* Gupta, A.K., 3:26454, 3:26455
Chu, T.K., *See* Schuss, J.J., 3:27440
Chu, Y., *See* Selucky, M.L., 3:25900
Chu, Y.K., *See* Barish, B.C., 3:27115
Chubb, C.R., *See* Roe, J.M., 3:26834
Chulick, E.T., *See* Stokstad, R.G., 3:27336
Chulyukina, A.V., *See* Kovalev, G.I., 3:25787
Cintula, T.C., Licensed operating reactors. Operating units status report, data as of 12-31-77, 3:26209 (NUREG—0020(Vol.2)(No.1))
Cioffi, P.L., *See* Sage, W.L., 3:25711
Cipolla, S.J., *See* Otterberg, J.E., 3:26462
Ciscato, D., *See* Bertolini, E., 3:27646
Cisneros, E.L, Drift chamber and pulse height readout systems using analog multiplexing, 3:26831 (SLAC-PUB—1844)
Clark, J.H., *See* Leary, K.M., 3:26692
Clark, R., Potential environmental impact of compounding and fabricating industries: a preliminary assessment. Final report, 3:26936 (PB—273603)
Clarke, J., *See* Gamble, T.D., 3:26711
See Ketchen, M.B., 3:26601
Clauser, M.J., *See* Ramirez, J.J., 3:26793
Clayton, J.L., Preliminary report: petroleum geochemistry of the Denver basin, 3:25741
Clayton, R.K., Annual progress report, September 1, 1976—November 30, 1977, 3:26945 (COO—3162-36)
Cleland, R.E., Studies on the control of cell wall extension. Progress report, July 1, 1976—September 1, 1977, 3:26949 (RLO/2225/T19—43)
Clemens, K., *See* Klein, H., 3:26380
Clemons, V.D., PWR Blowdown Heat Transfer Separate-Effects Program. Thermal-Hydraulic Test Facility experimental data report for test 105, 3:26440 (ORNL/NUREG/TM—143)
Cleveland, J.C., *See* Ball, S.J., 3:26255
Cline, J.F., Revegetation of a waste disposal site in the 200 areas of the Hanford Reservation, 3:26908 (PNL—2454)
Cloth, P., *See* Hecker, R., 3:27610
Cnops, A.M., Experimental limits on heavy lepton production by neutrinos, 3:27106 (BNL—23513)
Cobb, J., *See* Anderson, M., 3:26814
Coccorese, E., *See* Bertolini, E., 3:27646
Cochard, H., *See* Bellus, F., 3:25842
Cocke, C.L., K-shell capture by protons from O_2, N_2, and Ne, 3:27070
See Gray, T.J., 3:27077
Coffey, H.E., Solar—geophysical data number 396, August 1977. Part I. (Prompt Reports). Data for July 1977—June 1977, 3:27027 (PB—273617)
Solar—geo/physical data number 396, August 1977. Part II (comprehensive reports). Data for February 1977—January 1977 and miscellanea, 3:27028 (PB—273618)
Cohen, A.S., Cost/effectiveness analysis of the Illinois ozone episode regulation (R75-4). Final Report, 3:26890 (PB—270896)
Cohen, B.I., Effects of beat-wave electron trapping on stimulated Raman and Thomson scattering, 3:27569
Cohen, M.O., *See* Schechter, H.S., 3:27042
Cohen, N., Review of rate coefficients in the D_2-F_2 chemical laser system. Interim report, 3:26731 (AD-A—043812)
Colchin, R.J., *See* Foster, C.A., 3:27664
Cole, J.D., Shape coexistence in ^{186}Hg and the decay of ^{186}Tl, 3:27370
Colello, R.G., Automobile drivelines. Final report, June—December 1974, 3:26586 (PB—269591)
Coleman, G.C., *See* Vant-Hull, L., 3:26034
Coleman, P., *See* Barker, T.G., 3:26864
Collins, B.A., Geology of the Coal Basin area, Pitkin County, Colorado, 3:25687
Collins, C.J., *See* Stang, P.J., 3:26685
Collins, T., *See* Diebold, R., 3:26802
Collins, W.E., Properties of the second K/sup π/+ band in ^{156}Gd, 3:27371
Combette, P., French irradiation test experience for carbide fuels, 3:26309
Comiso, J.C., Measurement of the $^{12}C(\pi^+, \pi^+ + p)^{11}B$ reaction cross section, 3:27333 (ORO—4043-37, pp 23-24)
Commins, E.D., *See* Neuffer, D.V., 3:27054
Compton, R.N., *See* Warmack, R.J., 3:27066
Conklin, J.C., *See* Ball, S.J., 3:26255
Conn, R.W., High-performance non-circular tokamak power reactor design study - UWMAK-III, 3:27601
See Michaelson, P.F., 3:27640
Connolly, P.L., *See* Cnops, A.M., 3:27106
Connor, J.W., Scaling laws for plasma confinement, 3:27461
Conte, A.A. Jr, Deuterated fluids: deuterated synthetic hydrocarbon fluid and grease. Final report, 3:26690 (AD-A—042618)
Cook, N.G.W., Appraisal of hard rock for potential underground repositories of radioactive wastes, 3:25937 (LBL—7004)
Cook, V., *See* Jonckheere, A.M., 3:27144
Cooper, A.L., Low frequency instability of liquid liner implosions driven by multiple free pistons. Memorandum report, 3:27536 (AD-A—043284)
See Book, D.L., 3:27600
Cooper, B.R., Search criterion for lattice internal rearrangement modes: Correlation between lattice structural and magnetic structural transitions, 3:26630
Cooper, F., Emission testing and evaluation of Ford/Koppers coke pushing control system. Volume I. Final report. Report for Dec 73—Aug 77, 3:25684 (PB—273812)
Pressure generation due to a temperature discontinuity at a liquid-liquid plane interface, 3:27087
See Bender, C.M., 3:27272
Cooper, L.R., General considerations of the design of instruments for use in coal mines, 3:25703
Cooper, M.D., *See* Fisher, T.R., 3:27375
Cooper, R.B., *See* Hamill, W.D., 3:26686
Cooper, W.S., *See* Berkner, K.H., 3:27658
Coote, R.I., Non-rotating device for in-situ inspection of pressure tube in CANDU nuclear reactors, 3:26271
Coppi, B., Theory of the ubiquitous mode, 3:27555
See Basu, B., 3:27553
Corbett, J.D., Metal—metal bonded clusters in transition metal groups 3 and 4. Synthesis and structure of three M_6X_{12}-type clusters for scandium and zirconium, 3:26677
Corbett, W.E., Summary of the effects of important chemical variables upon the performance of lime/limestone wet scrubbing systems. Interim report, 3:25679 (EPRI-FP—639)
Corcoran, V.J., Feedback and acousto optic isolation effects on laser stability. Final report, June 1975—June 1976, 3:26721 (AD-A—042346)
Corrigan, T.M., Unified model studies of N = 84 and N = 80 nuclei, 3:27367 (IS-T—793)
Cortez, J.R., Photon and beta response of a new thermoluminescent dosimeter badge, 3:26824 (LA-UR—77-3001)
Corwin, W.C., *See* Tonn, J.F., 3:27345
Cosoli, G., *See* Calza-Bini, A., 3:26302
Costello, F.A., *See* Kursh, S.J., 3:26053
Costeseque, P., Experiments of syntheses of carbonate minerals by thermal diffusion in porous media, 3:26122
Cottingame, W., *See* Iversen, S., 3:27335
Courtemanche, A., *See* Bubb, E., 3:27314
See McCarthy, J., 3:27377
Cousyn, Rene, Civil engineering work, 3:26205
Covarelli, M., *See* Cecchi, P., 3:26299
Covlin, R.J., *See* Fast, C.R., 3:25861
Cowan, G.A., *See* Maeck, W.J., 3:25903
Cowan, R.L. II, *See* Gordon, G.M., 3:26401, 3:26402
Cowley, A., *See* Galichon, P., 3:25914
Cox, A.N., Cepheid pulsation theory and multiperiodic Cepheid variables, 3:27022
Cox, C.M., US experience in irradiation testing of advanced oxide fuels, 3:26303
See Simmons, J.M., 3:26293
Cox, C.R., *See* Roberson, P., 3:27130
Cox, D.E., *See* Elnahwy, S., 3:26643
Cox, J.P., *See* Cox, A.N., 3:27022
Coy, D.E., *See* Vasilik, D.G., 3:26888
Craig, P.P., *See* Levine, M.D., 3:26516
Cram, P.J., Low temperature oxidation process for the recovery of bitumen, 3:25896
Craven, J.D., Energization of polar-cusp electrons at the noon meridian. Progress report, 3:27037 (AD-A—042687)
Crawford, E.A., *See* Hoffman, A.L., 3:27481
Crawford, H.J., *See* Lindstrom, P.J., 3:27122
Crawford, R.B., *See* Shay, H.D., 3:27673
Crawley, H.B., *See* Leeper, R.J., 3:27143
See Whitmore, J., 3:27139
Crawley, H.J., *See* Hucklesby, R.J., 3:27696
Creamer, D.B., Scalar propagators in a pseudoparticle field, 3:27259
Crellin, G.L., Modelling the time dependent nature of structural reliability, 3:26357 (GEFR-SP—050)
Creutz, M., Topological tunneling and Goldstone gluons, 3:27254
Crewther, R.J., Asymptotic behavior in quantum field theory, 3:27298
Crocker, M.E., *See* Donaldson, E.C., 3:25746
Crockett, P.W., Radiation effects on cells and chromosomes (A bibliography with abstracts). Report for 1964—August 1977, 3:26988 (NTIS/PS—77/0753)

Croft, W.J., *See* Stephens, J.R., 3:26578
Croisant, W.J., *See* McCormack, R.G., 3:26660
See Sieber, D.C., 3:26659
Crosby, W.H., Splenic remodeling of red cell surfaces, 3:26963
Cross, A., Fuel assembly for a nuclear reactor, 3:26330
Crostack, H.A., *See* Bretfeld, H., 3:26360
Crowell, J.M., *See* Mullaney, P.F., 3:26961
Crowley, W.P., SIMPLE code, 3:26770 (UCID—17715)
Csom, Gy., *See* Bereznai, T., 3:26249
Csonka, P.L., Opportunities to produce coherent soft x-rays at Stanford, 3:26740 (RLO/2230/T4—191)
Possibility of coherent hard x-ray production by pumping with synchrotron radiation and low energy photons. Period covered: November 17, 1976—August 16, 1977, 3:26741 (RLO/2230/T5—192)
Csorna, S., *See* Ballagh, H.C., 3:27114
See Jonckheere, A.M., 3:27144
Cuddihy, E.F., Consideration of encapsulants for photovoltaic arrays in terrestrial applications, 3:25999
Culhane, J.L., *See* Zarnecki, J.C., 3:27030
Cumo, M., *See* Campolunghi, F., 3:26184
Cuniberti, R., *See* Burn, K., 3:27609
Curnutte, B., *See* Cocke, C.L., 3:27070
Curry, M.G., *See* Greene, M.R., 3:26496
Curtis, O.L. Jr., *See* Srour, J.R., 3:26836
Cushing, C.E., *See* Cataldo, D.A., 3:25948
Cutkosky, R.E., Does the baryon spectrum reveal a diquark structure, 3:27225
Cybulskis, P., *See* Bauer, A.A., 3:26306

D

D'yachenko, P.P., *See* Piksaikin, V.M., 3:27383
D'yachenko, V.V., *See* Glushchenko, N.F., 3:26760
Daake, R.L., *See* Corbett, J.D., 3:26677
Dabbousi, O.B., *See* Ley, L., 3:26608
Dadash-Zade, M.A., *See* Kasimova, Sh.S., 3:25759
Dado, S., *See* Lys, J.E.A., 3:27126
Daellenbach, C.B., Method for rapid particle size analysis by hydrosizing and nuclear sensing, 3:26832
Dafler, J.R., Assessment of thermochemical hydrogen production, 3:25960 (NP—22964)
Dagenhart, W.K., *See* Ronningen, R.M., 3:27374
See Stewart, L.D., 3:27663
Dakhov, A.I., *See* Nekrasov, V.G., 3:26167
Dal'karov, O.D., Light antiprotonic atoms and quasinuclear mesons, 3:27236
Dalton, V., *See* Campbell, J.H., 3:25644
Damask, A.C., *See* Elnahwy, S., 3:26643
Damm, C.C., Target-plasma production by laser irradiation of a pellet in the Baseball II-T experiment, 3:27531 (UCRL—52363)
Daneshvar, K., *See* Geesaman, D.F., 3:27350
See Kovar, D.G., 3:27351
Daniels, D.W., *See* Mayer, F.J., 3:27441
Daniels, E.J., *See* Seay, J.G., 3:25856
Daniels, W.B., *See* Elnahwy, S., 3:26643
Danil'chenko, V.V., Thermal and electrical conductivity of tantalum carbide at high temperatures (1500—3000°K), 3:26616
Danyluk, S., Failure of the thermocouple assembly from the HYGAS coal pretreatment vessel: failure analysis report, 3:25621 (ANL/MSD/FE—77-6R)
Danzmann, H.J., *See* Butz, H.P., 3:26466
Dargeiko, M.M., Stability of plasma column position control system, 3:27498
Das, A., Super-Higgs effect in a new class of scalar models and a model of super QED, 3:27257
Das, S.C., Approximate method for calculating free vibrations of a large-wind-turbine tower structure, 3:26126 (ERDA/NASA/1028—77/12)
Dashen, R., *See* Callan, C.G. Jr., 3:27158
Datla, R.U., Stark profile measurements on Lyman series lines of Al XIII, 3:27471
Dattagupta, S., Breakdown of the "white noise approximation" in the Moessbauer relaxation spectra: The case of $Cs_2NaYbCl_6$, 3:26653
Daublebsky, P., Burst protection for containers under high pressure, in particular steam generators, 3:26252
Daugherty, W.L., *See* Millican, R.W., 3:26854
Davids, C.N., New isotopes of interest to explosive nucleosynthesis, 3:27355 (ANL—77-60, pp 58-61)
See Elwyn, A.J., 3:27337
See Geesaman, D.F., 3:27350
Davidson, J.R., *See* Martin, C.W., 3:25768
Davidson, R.C., Anomalous transport in high-temperature plasmas with applications to solenoidal fusion systems, 3:27556
Kinetic and numerical studies of microstability properties and anomalous transport in theta pinches, 3:27549
See Uhm, H., 3:27547
Davies, J., Conserving uranium without the fast breeder, 3:26506
Davies, K.T.R., Rupture of the neck in nuclear fission, 3:27380
Davis, A.H., Calculation of two-phase flow and fracturing in a porous medium (abstract), 3:26085
Davis, D.E., Method of making nuclear fuel bodies, 3:25921
Davis, H.A., Experimental studies on generation and behaviour of field-reversing E- and P-layers, 3:27494
Davis, H.L., *See* Ulehla, M.K.V., 3:27404
Davis, H.R., *See* Jewell, W.J., 3:26010
Davis, H.T., Competing risk model for reduction in life expectancy from radiogenic latent cancer, 3:26985 (SAND—77-1352C)
Davis, J.C., *See* Booth, R., 3:26789
Davis, J.R., *See* Hopkins, R.H., 3:25990
Davis, T.L., Seismic investigation of the Colorado Front Range Zone of flank deformation immediately north of Golden, Colorado, 3:25733
Dawance, G., Process and device of leak testing of works, especially concrete works, 3:26386
Dawson, J.M., *See* Okuda, H., 3:27570
See Pritchett, P.L., 3:27572
Day, D., Threshold electrodisintegration and quasi-free scattering from ^{3}He, 3:27322 (ORO—4043-37, pp 46-48)
See McCarthy, J., 3:27378
Day, H.W., Internally consistent thermodynamic data (abstract), 3:26118
de Almeida, A.A., Wave-wave interactions in a plasma, 3:27591
de Harven, E., *See* Evenson, D.P., 3:26974
de Jager, C.W., *See* Euteneuer, H., 3:27343
de Lima, W., *See* de Vasconcelos Martins, J.M., 3:26056
de Lorge, J., Operant behavior and colonic temperature of squirrel monkeys (saimiri sciureus) during microwave irradiation. Interim report, 3:27001 (AD-A—043706)
de Paz, J.F., *See* Madell, J.T., 3:26324
de Vasconcelos Martins, J.M., Swimming pool heating by solar energy, 3:26056
de Vries, H., *See* Euteneuer, H., 3:27343
De Winton, C., Profile of the Southern Feeder, 3:25865
Dealy, R.J., *See* Hathaway, S.A., 3:25973
Dean, N.R., Glow discharge processing vs bakeout for aluminum storage ring vacuum chambers, 3:26815 (SLAC-PUB—2053)
Dean, N.W., *See* Chang, V., 3:27229
Dean, P., Traction drives: a review of their configurations and considerations for their selection for automotive applications. Technical report, 3:26585 (MTI—78TR11)
Deb, S.K., *See* Jain, A.K., 3:27407
Decoste, R., High energy ion expansion in laser-plasma interactions, 3:27669 (NRL-MR—3669)
High-energy ion expansion in laser-plasma interactions, 3:27442
See Felber, F.S., 3:27532
Defauchy, J., Device for thermal shielding of a reactor vessel, 3:26285 (ANL-Trans—1121)
DeFrees, D.J., Priori calculations on isotopic exchange equilibria, 3:26691
DeGrand, T.A., Jet structure in e^+e^- annihilation as a test of quantum chromodynamics and the quark-confining string, 3:27176
Dei-Cas, R., *See* Bonnel, P., 3:27612
Deich, M.E., Analysis of nonsteady flows with phase conversions, 3:26772
Deitrich, L.W., Summary and evaluation of fuel dynamics transient-overpower experiments: status 1974, 3:26431 (ANL—77-44)
DeKalb, E., *See* Winge, R.K., 3:26664
del Papa, C., Inclusive production of rho^0 in inelastic muon-nucleon scattering, 3:27102
Delannoy, G., Future use of coal in energy generation, 3:25723
Delellis, R., *See* Bruzzone, H., 3:27493
Delisle, J.P., *See* Abramson, R., 3:26287
Dell, G.F., *See* Amaldi, E., 3:27133
Della Valle, R.S., *See* Brookins, D.G., 3:25912
Delmas, J., *See* Grauby, A., 3:26420
Delorey, D.E., Data processing and analysis for icecap and related projects. Final scientific report, 4 December 1972—3 December 1976, 3:27034 (AD-A—042261)
Delpeyroux, P., Advanced mixed oxide fuel element for fast reactors, 3:26304
Delvin, S.A., *See* Riccardella, P.C., 3:26437
Delvin, W.L., Laboratory quality assurance and its role in nuclear fuel reprocessing and refabrication, 3:26661 (HEDL-SA—1258)
Demekhina, N.A., *See* Abramyan, L.O., 3:27105
DeMeo, E.A., Perspectives on utility central station photovoltaic applications, 3:26029 (EPRI-ER—589-SR)
Demetroulis, N.M., Energy control system study for Fort Belvoir, Virginia. Final report, 3:26553 (AD-A—042641)
Demirkhanov, R.A., Plasma heating in a toroidal system by a helical quadrupole RF field with $\omega < \omega$sub(Bi), 3:27452
Dengel, O.H., *See* Bowen, R.E., 3:26727
Dengler, L.A., Laboratory investigations of permeability loss in sedimentary rocks (abstract), 3:26119
Denholm, D., *See* Bush, T.W., 3:25619
Derrick, M., Diffractive process in six-prong proton-proton interactions at 205 GeV/c, 3:27125
See Barish, S.J., 3:27116
Derrough, M., Ownership transfer of LNG plants, 3:25835
Deryavko, I.I., *See* Danil'chenko, V.V., 3:26616
Deschamps, P., *See* Bourrier, P., 3:27694
Desi, S., *See* Bereznai, T., 3:26249

DesRoches, P.R., *See* Lindsten, D.C., 3:26933
Detman, R., Quarterly technical progress report, October—December 1977, 3:25631 (FE—2240-79)
Deublein, O., Lingen nuclear power plant: construction and operation, 3:26222
Deupree, R.G., Instability strip of the anomalous Cepheids in the Draco dwarf spheroidal galaxy, 3:27023
Devereux, M., *See* Iversen, S., 3:27335
Devlin, T., *See* Heller, K., 3:27129
Diambekov, S.S., *See* Nekrasov, V.G., 3:26167
Dibiase, J.A., Linear and non-linear calculation of the tearing mode in reversed field pinches, 3:27560
Dick, R., *See* Clark, R., 3:26936
Dickerhoof, D.W., *See* Gary, J.H., 3:25665
Diebold, R., Comparison of anti p anti p and pp luminosities at Fermilab, 3:27215 (ANL-HEP-CP—77-81)
Crossing geometry for Main Ring on Doubler collisions, 3:26802 (ANL-HEP-CP—77-60)
Dierschke, E.G., C. W. GaAs diode laser. Final report 1 Dec 73—2 Dec 74, 3:26735 (AD-B—015785)
Dietrich, B., Tap water heating with solar energy, 3:26054
Dietrich, K., General form of the cross section of deep inelastic collisions, 3:27392
Dikhter, I.Y., Experimental equation of state of a highly ionized cesium plasma, 3:27492
diLauro, G.F., *See* Caspersson, S.A., 3:26323
Dimock, D., *See* Bretz, N., 3:27472
Dines, K.A., Iterative reconstruction of underground refractive index distributions from cross-borehole transmission data, 3:27006 (UCRL—52348)
Dix, G.E., *See* Brayman, K.W. George, D.K., 3:26398
Dixon, R.H., Intensity inversion in the Balmer spectrum of C^{5+}, 3:27533
Dmitrenko, Z.F., Characteristics of the excitation of Al_2O_3—Eu and Y_2O_3—Eu surface luminescence centers, 3:26640
Dmitriev, V.P., *See* Osipov, K.A., 3:26624
Dobrovol'skii, N.M., *See* Alekseevskii, N.E., 3:26655
Dobson, J.E., Nationwide assessment of water quantity impacts of the National Energy Plan. Volume I. Summary and conclusions, 3:26932 (ORNL/TM—6098)
Doerbeck, F.H., *See* Carr, D.L., 3:26724
Doerner, R.C., *See* Deitrich, L.W., 3:26431
Doher, L.W., *See* Pontius, P.E., 3:25953
See Shuler, L.E., 3:26840
Doherty, J.B., *See* Cross, A., 3:26330
Dolby, R.E., Underclad cracking in nuclear vessel steels, 3:26359
Dolgopolov, S.G., Use of metal-oxide-metal diode for multiplying and mixing laser frequencies within the near infrared and the visible range, 3:26755
Doll, C.K., CTI water cooling tower thermal performance: testing procedures and instrumentation, 3:26129 (CONF-770151—9)
Dolly, E.D., Geology and gas exploration potential, Upper Cretaceous and Lower Tertiary strata, northern Raton basin, Colorado, 3:25828
Dombrovskii, V.I., Investigation of contamination and corrosion of regenerative air preheaters during combustion of Ekibastuz coal, 3:26166
Domnin, Yu.S., Laser as a means of transferring a standard frequency into the submillimeter range, 3:26757
Domokos, G., Internal symmetries and ghost symmetries, 3:27246
Donahue, J., *See* Gram, P.A.M., 3:27058
Donaldson, E.C., Review of petroleum oil saturation and its determination, 3:25746 (BERC/RI—77/15)
Donat, E.V., *See* Ponomarev, G.S., 3:25780
Donnelly, R.G., *See* LaMantia, C.R., 3:25678
Dooher, J., *See* Amaldi, E., 3:27133
Dorfan, D., *See* del Papa, C., 3:27102
Dorfan, J.M., *See* Scharre, D.L., 3:27113
Dortch, M.S., *See* Fontane, D.G., 3:26481
Dory, R.A., *See* Peng, Y.M., 3:27437
Dove, W.F., *See* Hammer, D.A., 3:27438
Dover, C.B., Possibility of charmed hypernuclei, 3:27228
See Moffa, P.J., 3:27328
Dowling, J.M., Infrared emissivities of micron-sized particles of C, MgO, Al_2O_3, and ZrO_2. Final report, 3:26636 (AD-A—042144)
Downs, W., *See* Sage, W.L., 3:25711
Dragel, G.M., *See* Danyluk, S., 3:25621
Drell, S.D., Quark confinement, 3:27206 (SLAC-PUB—2020)
Driatskaya, Z.V., *See* Tereshina, I.V., 3:25819
Driver, P.M., New chrome black selective absorbing surface, 3:26064
Dronov, Yu.D., *See* Parilov, V.A., 3:25709
Duba, A.G., Electrical conductivity of coal and coal char, 3:25674
Dubinskaya, V.Ya., *See* Tsybulevskii, A.M., 3:25773
Dubov, V.N., *See* Livshits, M.A., 3:26176
Dubovikov, M.S., Rising cross section and the multi-Pomeron bootstrap, 3:27286
Duckwald, C.S., *See* Gilman, J.D., 3:26207
Dudakov, L.P., Absorption of ammonia with organic solvents, 3:25969
Dudley, W.W. Jr., Hydrology, 3:26896 (TID—26712, pp 35-51)
Dudorov, Yu.D., *See* Levit, G.T., 3:26169
Duedder, H.D., Calculations of the laserlight-transmission in laser-fusion-reactors at various densities and density-profiles, 3:27668 (Juel—1399)
Duerr, H.P., Recent developments in nonlinear spinor theories, 3:27306
Duffy, C.J., Uranium solubilities in the Oklo reactor zones, 3:27016 (LA-UR—77-2818)
Duke, D.W., *See* Leeper, R.J., 3:27143
Dul'yan, L.S., Breakup of relativistic positronium in the field of an atom, 3:27063
Dumnov, V.P., *See* Livshits, M.A., 3:26176
Dunaway, P.B., *See* White, M.G., 3:26909
Duncan, D.A., Research and development of rapid hydrogenation for coal conversion to synthetic motor fuels (riser cracking of coal). Second quarter report, July 1—September 30, 1977, 3:25656 (FE—2307-25)
Duncan, M.G., Phase-insensitive detectors for ac resistance bridges with application to temperature control systems, 3:26843 (Y/DA—7468)
Dundurs, J., *See* Weertman, J., 3:26106
Dunlap, B.D., *See* Dattagupta, S., 3:26653
Dunlop, M.L., *See* Winfrey, J.H., 3:27578
Dunn, R.M., Coal-oil slurry combustion demonstration, Phase I. Monthly report, November 1977, 3:25714 (FE—2564-9)
Coal—oil slurry combustion demonstration, Phase I. Monthly report, December 1977, 3:25715 (FE—2564-10)
Dunwoodie, W., *See* Gilchriese, M.G.D., 3:27138
Duong-van, M., Some results in $\mu h^{+-} X$ process, 3:27108 (SLAC-PUB—1822)
See del Papa, C., 3:27102
Dupree, T.H., Renormalized dielectric function for collisionless drift wave turbulence, 3:27509
Dushin, L.A., Modulation of electromagnetic waves in an isotropic inhomogeneous plasma, 3:27590
Dusseault, M.B., Stress state and hydraulic fracturing in the Athabasca Oil Sands, 3:25892
Dutton, R.W., *See* Hickok, W.W., 3:26130
Duvall, T.L. Jr, Comparison of H-alpha synoptic charts with the large-scale solar magnetic field as observed at Stanford. Scientific technical report, 3:27025 (AD-A—043336)
Duvel, W.A. Jr., State-of-the-art of FGD sludge fixation. Final report, 3:25680 (EPRI-FP—671)
Dux, C.D., National coal utilization assessment: modeling long-term coal production with the Argonne coal market model, 3:25720 (ANL/AA—13)
See Krohm, G.C., 3:25719
Dvoinnishnikov, V.A., Special characteristics of the aerodynamic organization of the working process in a conical-type combustion chamber for a magnetohydrodynamic unit, 3:26535
Dysthe, K.B., Non-linear Langmuir wave modulation in collisionless plasma, 3:27575
Dzhavadova, R.A., *See* Gadzhi-Kasumov, A.S., 3:25817
Dzhuraev, D.R., *See* Golovashkin, A.I., 3:26626
Dzyuba, N.E., *See* Maklakova, V.P., 3:26158

E

Early, R., *See* Anderson, M., 3:26814
Eastman, T.E., *See* Wolcott, J.H., 3:27044
Eaton, R.A., Pavement recycling using a heavy bulldozer mounted pulverizer. Special report, 3:26554 (AD-A—046008)
Eberhardt, L.L., *See* Gilbert, R.O., 3:26912
Eberly, J.H., Coherent dynamics of N-level atoms and molecules. I. Numerical experiments, 3:27085
See Bialynicka-Birula, Z., 3:27086
See Wong, N.C., 3:27051
Ebert, P.J., *See* Grader, R.J., 3:27060
Eck, J.S., Low energy elastic scattering from ^{28}Si targets using projectiles with $9 < \text{or} = A < \text{or} = 18$, 3:27344
Eckbreth, A.C., Review of laser raman and fluorescence techniques for practical combustion diagnostics. Final report on Task 1, October 1976—March 1977, 3:26701 (PB—269653)
Ecker, H., Heat exchanger designed as longitudinal counter flow equipment, 3:26268
Eckhause, M., *See* Roberson, P., 3:27130
Eckhoff, N.D., *See* Chen, Y.F., 3:26250
Edelman, B., *See* Heller, K., 3:27129
Ederer, D.L., *See* Callcott, T., 3:26607
Edwards, F.M., *See* Zaidins, C.S., 3:26828
Edwards, R.T., *See* Heller, K., 3:27129
Efendiev, T.B., *See* Krutiev, V.A., 3:26195
Efros, V.D., Single-particle basis and translational invariance in microscopic nuclear calculations, 3:27388
Egashira, K., Countermeasures to prevent leakage from valve stem area, 3:26370
Egerev, V.V., Calculation and optimization of existing energy-technological systems for ammonia production, 3:25972
Egiazarov, Yu.G., Crude oils from new commercial fields in Belorussia, 3:25815
Egorenkov, P.M., *See* Goncharov, V.V., 3:26428
Egorov, S.A., Application of a two superconducting ellipsoidal coil

system without external magnetic field as an inductive energy storage (Part 1), 3:27651 (LA-tr—78-12)
Eguchi, T., Collective phenomena and renormalization of nonlinear spinor theories, 3:27288
Ehlers, K.W., *See* Berkner, K.H., 3:27658
Eichholz, G.G., Validity and design of environmental surveillance systems for operating nuclear power plants. Final report, 3:26412 (EPRI-NP—604)
Eichten, E., Influence of hadronic decay channels in confinement models of the new resonances, 3:27222
Eisenstein, R.A., *See* Roberson, P., 3:27130
Ejima, S., *See* Prater, R., 3:27543
Eke, P.W.A., Experiences in the commissioning of liquid natural gas carriers, 3:25875
Ekstrom, M.P., Design of stable 2-D half-plane recursive filters using spectral factorization, 3:27711 (UCRL—80078)
El'-Nagi, A., *See* Bannik, B.P., 3:27118
El'darov, T.R., *See* Peisakhov, S.I., 3:25758
El-Arabaty, A., Technology and characteristics of breakdown and plasma in shock tube arrangements, 3:27489 (EUR—5602, pp 305-310)
El-Debeiky, S., *See* El-Arabaty, A., 3:27489
El Gabalawi, N., *See* Fujita, T., 3:26038
El Hamamsy, M., *See* Elnahwy, S., 3:26643
El-Khalafawi, T.A., *See* El-Arabaty, A., 3:27489
Elder, C.H., Effects of hydraulic stimulation on coalbeds and associated strata, 3:25689 (BM-RI—8260)
Elesin, V.F., Theory of destruction of superconductivity by optical pumping, 3:27405
Elfimov, A.G., *See* Demirkhanov, R.A., 3:27452
Elias, J.E., *See* Halliwell, C., 3:27124
Elie, X., *See* Abramson, R., 3:26287
Eliseyev, V.S., *See* Filimonova, T.A., 3:25821
Ellis, A.E., Environmental qualification of safety-related Class 1E process instrumentation, 3:26445 (WCAP—9211)
Elnahwy, S., Pressure dependence of the lattice parameters of anthracene up to 5.4 kbar and a re-evaluation of the elastic constants, 3:26643
Elrod, D.C., *See* Giles, G.E., 3:26594
Elton, R.C., *See* Dixon, R.H., 3:27533
Elwyn, A.J., Absolute cross sections for deuteron-induced reactions on ^{6}Li at energies below 1 MeV, 3:27337
See Meyer-Schuetzmeister, L., 3:27347
Ely, R., *See* Scharre, D.L., 3:27113
Emery, R.M., *See* Cataldo, D.A., 3:25948
See Rickard, W.H., 3:25945
Emison, W.B., *See* White, C.M., 3:26903
Emmett, J.L., Laser fusion program overview, 3:27674 (UCRL—52000-77-8, pp 1-4)
Engel, G., *See* Seiger, H., 3:26214
Engelmann, F., Transport properties of a tokamak plasma with impurities in the collision-dominated regime, 3:27521
See Bertolini, E., 3:27624
Engelmann, R., *See* Barish, S.J., 3:27116
Engelmann, T.R., Real parts of the pion-proton forward scattering amplitude, 3:27224
England, G., Nuclear power - a report on progress, 3:26452
England, G.L., Steady-state stresses in concrete structures subjected to sustained and cyclically varying temperatures, 3:26363
Engler, A., *See* Lys, J.E.A., 3:27126
Englert, F., Dynamical symmetry breakdown, 3:27248
Engonyan, S.S., *See* Gorobets, B.S., 3:25905
Enomoto, H., *See* Ishihama, W., 3:25676
Ensign, J.C., Biomass production from animal wastes by photosynthetic bacteria, 3:26028
Ensminger, J.T., Shallow land burial of low-level radioactive wastes, 3:25938 (ORNL/EIS—115)
Epik, I.P., Problems of energy utilization of bituminous shale, 3:25901
Eppel, S.A., *See* Kaliberdo, L.M., 3:26678
Eramzhyan, R.A., *See* Batusov, Y.A., 3:27396
Erickson, A.J., Comparison and interpretation of borehole and marine heatflow data from the Mediterranean and Aegean Seas (abstract), 3:26109
Erickson, W.C., Use of general purpose software in casting solidification simulation, 3:26597
Ermakov, G.V., Nuclear fuel in the fuel and energy complex, 3:26507
Erskine, J.R., *See* Rehm, K.E., 3:27352
Ertakova, L.D., *See* Filimonova, T.A., 3:25821
Erwin, A.R., *See* Whitmore, J., 3:27139
Estabrook, K., Properties of resonantly heated electron distributions, 3:27444
Estes, J.A., Population estimates and feeding behavior of sea otters, 3:26942 (TID—26712, pp 511-526)
See Morrison, P.R., 3:26970
See Palmisano, J.F., 3:26928
Eteiba, M., *See* El-Arabaty, A., 3:27489
Ettinger, D.G., Infrared-to-visible conversion in (Y, Yb, Er)F_3 and (Y, Yb, Ho)F_3, 3:26648
Ettinger, H.J., *See* Morales, R., 3:26997
Euteneuer, H., Elastic electron scattering from the multipole moment distributions of ^{25}Mg, 3:27343
Evans, H.C., *See* Cerny, J., 3:26803
Evans, R.S. II, *See* Finney, C.D., 3:26008
Evans, T.D., *See* Vasalos, I.A., 3:25659
Evenson, D.P., Ultrastructural studies on Friend leukemia virus, 3:26974 (CONF-770504—, pp 1-13)
Everett, K.R., Geomorphology, 3:26900 (TID—26712, pp 161-177)
Soils, 3:26901 (TID—26712, pp 179-202)
Everett, R.G., *See* Shannon, J.D., 3:26213
Ewbank, W.B., *See* Kocher, D.C., 3:26991
Eylon, S., *See* Tuszewski, M., 3:27463
Eylon, Y., Kinetic-energy considerations and the vacuum, 3:27283

F

Faber, J. Jr., *See* Shaked, H., 3:26637
Fackler, O., *See* Barish, B.C., 3:27115
Fadeev, V.V., *See* Abakumov, G.A., 3:26758
Faessler, A., Description of yrast traps in ^{176}Hf, 3:27368
Failla, L., Statistical analysis of low-radiation packages in the transport of radioactive material, 3:25923
Fair, J.A., *See* Ozbek, H., 3:26114
Fan, J.C.C., Wavelength-selective surfaces for solar energy utilization, 3:26070
Fan, P.F., *See* Stone, C., 3:26086
Farber, G., *See* Yang, R.T., 3:25710
Farfaletti-Casali, F., Improvements in or relating to nuclear fusion reactors, 3:27599
Farmer, O.A., *See* Ramshaw, J.D., 3:26765
Fassel, V.A., *See* Winge, R.K., 3:26664
Fast, C.R., Application of massive hydraulic fracturing to the tight Muddy "J" Formation, Wattenberg field, Colorado, 3:25861
Faustov, R.N., *See* Dul'yan, L.S., 3:27063
Favorite, F., *See* McAlister, W.B., 3:27021
Fedorov, A.P., *See* Maslyanskii, G.N., 3:25772
Fedorov, E.A., *See* Abakumov, G.A., 3:26758
Fedorov, E.M., *See* Zinger, N.M., 3:26547
Fedotov, S.I., *See* Basov, N.G., 3:27688
Feeley, J.J., *See* Konya, M.J., 3:26228
Fegley, M.M., *See* Boley, C.C., 3:25617
Feibelman, P.J., Theory of valence-band Auger spectra: GaAs(110), 3:26651
Felber, F.S., Fast expansions of laser-heated plasmas, 3:27532
Feldman, D., Progress report for a research program in theoretical high-energy physics, 3:27146 (COO—3130TA-340)
Feldman, D.W., *See* Liu, C.S., 3:26723
Feldman, G.J., $e^+ e^-$ annihilation into hadrons at SPEAR, 3:27098 (SLAC-PUB—1624)
Nonresonant multibody production by $e^+ e^-$ annihilation, 3:27101 (SLAC-PUB—1745)
See Scharre, D.L., 3:27113
Feller, J.M., *See* Scharre, D.L., 3:27113
Fender, H.B., *See* Murray, D.K., 3:25688
Fenneman, D.B., Hypersonic gas laser, 3:26745
Fenster, S., *See* Bart, G.R., 3:27241
Feofilov, G.P., Possibilities of improving the reliability of systems for automatic loading of coal bunkers, 3:25708
Ferbel, T., ISABELLE machine glossary, 3:26809 (BNL—23538)
See Chaney, D., 3:27121
See Mollet, W., 3:27123
Ferguson, D.R., *See* Mync, L., 3:26475
Fernandes, R., Lateral support structure for constant tension D-shaped coils in tokamak fusion devices, 3:27643 (WFPS-TME—063)
Fernow, R.C., *See* Briefel, E., 3:27140
Ferrari, G., *See* Campolunghi, F., 3:26184
Ferreira, E.M., Scattering of pions by deuterons at low and medium energies, 3:27230
Feshbach, H., *See* Boridy, E., 3:27127
Ffooks, R.C., Review of current LNG ship technology and an attempt to rationalize, 3:25869
Ficalora, P.J., *See* Pecora, L.M., 3:25685
Fichtl, G.H., *See* Perlmutter, M., 3:27031
Fieguth, T., *See* Gilchriese, M.G.D., 3:27138
Field, A.A., Matrix rotor fan combines heat recovery with balanced ventilation, 3:26550
Fielding, S.J., High-density discharges with gettered torus walls in DITE, 3:27625
Figgins, P.W., *See* Keister, P.L., 3:26666
Filacchioni, G., *See* Calza-Bini, A., 3:26302
Filges, D., *See* Hecker, R., 3:27610
Filimonov, N.M., *See* Shtur, V.B., 3:25753
Filimonova, T.A., Ozonolysis of asphaltenes, 3:25821
Fill, H.D.O.A., *See* Watson, F.V., 3:26352
Filloleau, E., *See* Allain, A., 3:26288
Finch, T.E., Limits and cost sensitivity of alternate parting handling methods. Volume I. Final summary report, December 1975—March 1977, 3:25692 (PB—270024)
Findlater, A.E., Operational experience with LNG ships, 3:25874
Finkenthal, M., *See* Schwob, J.L., 3:27490
Finn, P.A., Thermophysical properties of liquid uranium carbide, 3:26633
Finnemore, D.K., *See* Roeske, F. Jr., 3:26654
Finnerty, W.R., Biochemical basis of paraquat induced oleoresin production in pines, 3:26025 (SRO—0888-2, pp 12-60)
Multidisciplinary research program directed toward utilization of solar energy through bioconversion of renewable resources. Progress report, 3:26023 (SRO—0888-2)
Finney, C.D., Promoting faster anaerobic digestion: summary of progress and plans, 3:26008 (COO/2991—19, pp 17-44)

Finney, K.A., *See* Finney, C.D., 3:26008
Firestone, A., *See* Whitmore, J., 3:27139
Firth, L., *See* Butt, E.P., 3:27631
Fischbach, E., Analysis of weak-interaction effects in high-transverse-momentum hadron-hadron collisions, 3:27196
Implications of a nonzero neutrino mass for the process $\gamma\gamma \rightarrow \nu\text{nu-bar}$, 3:27200
Fischler, M., *See* Das, A., 3:27257
Fisher, E.R., Energy transfer in lasers. Final technical report, 3:26730 (AD-A—043808)
Fisher, S.T., Electrical induction heating: a new concept in in situ recovery, 3:25616
Fisher, T.R., Pion cross section measurements on aligned ^{165}Ho in the (3,3) resonance region, 3:27375
Fisk, H.E., *See* Barish, B.C., 3:27115
Fitzgerald, D.H., Energy dependence of the ^{119}Sn(p,n)^{119}Sn(IAS) reaction, 3:27365
Fitzgerald, T.J., *See* Wolcott, J.H., 3:27044
Fitzner, R.E., *See* Uresk, D.W., 3:25946
Flanz, J., *See* Euteneuer, H., 3:27343
Flato, M., Theory of analytic vectors and applications, 3:27410
Flatseth, H.H., *See* Mathiesen, T.C., 3:25844
Flatte, S.M., *See* del Papa, C., 3:27102
Flaum, C., *See* Kovar, D.G., 3:27341
Fleer, A., *See* Spencer, D.W., 3:26930
Fleischmann, H.H., *See* Davis, H.A., 3:27494
Fletcher, J.K., Solution of the time-dependent multi-group neutron transport equation using spherical harmonics, 3:26353
Florence, A.L., Laboratory investigation of stemming and containment in underground nuclear tests. Final report, 3:26849 (AD-A—042547)
Flower, M.F.J., Rare earth and other trace elements in historic Azorean lavas, 3:27009
Foh, S.E., *See* Dafler, J.R., 3:25960
Folomeshkin, V.N., *See* Gershtein, S.S., 3:27201
Fonck, R.J., Atomic diamagnetism and diamagnetically induced configuration mixing in laser-excited barium, 3:27048
Fong, A., *See* Scharre, D.L., 3:27113
Fontana, M.H., Breeder Reactor Aerosol Release and Transport Program. Quarterly progress report, April—June 1977, 3:26439 (ORNL/NUREG/TM—142)
Fontane, D.G., Marysville Lake hydrothermal study. Report 1. 900-mW project; hydraulic and mathematical model investigation. Technical report, August 1975—October 1976, 3:26481 (AD-A—042556)
Foote, J.H., *See* Damm, C.C., 3:27531
Foote, V., *See* Bretz, N., 3:27472
Ford, C.T., *See* Boyer, J.F. Jr., 3:25707
Ford, J.L.C. Jr., *See* Ronningen, R.M., 3:27373
Ford, R., *See* Book, D.L., 3:27600
Fore, C.S., *See* Ensminger, J.T., 3:25938
Forman, N., Towards a more conservative energy policy, 3:26517
Forster, G.A., Sodium flow calibration using a pulsed neutron activation technique on a 400mm (16 inch) pipe at LMEC, 3:26278 (ANL-CT—78-9)
Fortney, L.R., *See* Biswas, N.N., 3:27132
Foster, C.A., Solid hydrogen pellet injection into the ORMAK tokamak, 3:27664
Foulquier, L., *See* Grauby, A., 3:26420
Fournier, D., *See* Jonckheere, A.M., 3:27144
Fouse, G.W. Jr., Development of methods for determining organic free radical structures by electron spin resonance and application to the radiation chemistry of nucleic acid model compounds, 3:26694 (UR/3490/LCP—6)
Fowler, R.H., *See* Goldston, R.J., 3:27592
Fox, D.P., *See* Stang, P.J., 3:26685
Fox, K., Rotational-vibrational transition moments in excited states of spherical-top molecules, 3:27052
Fraas, A.P., ORNL fusion power demonstration study: fluid flow, heat transfer, and stress analysis considerations in the design of blankets for full-scale fusion reactors, 3:27617 (ORNL/TM—5960)
Fraley, J.E., Dry-process-sprayed coal mine sealants, an updated progress report, 3:25690 (BM-RI—8266)
Frank, A.A., *See* Beachly, N.H., 3:26583
Frank, L.A., *See* Craven, J.D., 3:27037
Franklin, H., *See* Bush, T.W., 3:25619
Franklin, N.L., Nuclear power in western society, 3:26415
Franz, J.A., Origin of certain heterocyclic compounds from depolymerization of lignite, 3:25669
Fraser, H.L., Recent advances in analytical electron microscopy, 3:26662 (CONF-770504—, pp 135-158)
Frederickson, J.P., *See* Pelletier, C.A., 3:26356
Freed, J.J., Cellular heredity in haploid cultures of somatic cells. Annual progress report, April 1976—July 1977, 3:26960 (COO—3110-28)
Freed, K.F., *See* Band, Y.B., 3:27067
Freeze, H.L., *See* Mende, H., 3:25932
Fretter, W.B., *See* Ballagh, H.C., 3:27114
Freytag, D., *See* Mollet, W., 3:27123
Fridman, A.M., *See* Mikhajlovskii, A.B., 3:27563, 3:27564
Fried, H.M., *See* Feldman, D., 3:27146
Friedberg, R., *See* Luttinger, J.M., 3:27409
Friedman, A., *See* Smither, R.K., 3:27364
Friedrich, G., Personnel monitoring by process computers in nuclear power stations, 3:26461
Use of an evaluation device for rod dosimeters in the process computer-aided personnel dosimetry monitoring at the Philippsburg nuclear power station, 3:26460
Friedrich, O.M., *See* Williamson, H.J., 3:26881
Friefeld, J., *See* Vant-Hull, L., 3:26034
Fritts, D.H., Electrode assembly for bipolar battery, 3:26491
Froeba, K., New Federal Act for protection against nuisances (BImSchV), 3:26891
Fronsdal, C., Super-gauge groups, 3:27204
Frost, W., *See* Perlmutter, M., 3:27031
Fugate, L.G., *See* Wells, J.C. Jr., 3:27357
Fujita, A., *See* Ishimasa, Y., 3:25886
Fujita, J., *See* Kadota, K., 3:27657
Fujita, T., Projection of distributed-collector solar-thermal electric power plant economics to years 1990—2000, 3:26038 (DOE/JPL/1060—1)
Fukuhara, H., *See* Martin, N.C., 3:26950
Fukui, K., Noise of cargo oil pumps and effect on accommodation of large tanker, 3:25809
Fukunishi, K., Coherence analysis of boiling water reactor noise, 3:26220
Fukuyama, A., *See* Momota, H., 3:27433
Fullen, R.E., *See* Levine, M.D., 3:26516
Fuller, R.C., Energy dependence in heavy-ion optical-potential elastic scattering, 3:27393
Fuller, R.G., Ecological consequences of nuclear testing, 3:26907 (TID—26712, pp 627-649)
Previous scientific investigations, 1867—1967, 3:26899 (TID—26712, pp 141-159)
See Merritt, M.L., 3:26895
Fulmer, C.B., *See* Saltmarsh, M.J., 3:26794
Fumi, F.G., Physics of semiconductors, 3:26767
Funahashi, K., *See* Ozaki, K., 3:26569
Funk, W.T., Hydrogen fluoride/deuterium fluoride laser at the naval postgraduate school. Master's thesis, 3:26719 (AD-A—042341)
Fuqua, W.C., *See* Nethaway, D.R., 3:27381
Furlan, P., *See* Budini, P., 3:27203
Fursa, I.V., *See* Beresnevich, P.V., 3:25704
Furumoto, A.S., Evaluation of geophysical techniques for geothermal exploration on an active basaltic volcano (abstract), 3:26093
Furuta, K., *See* Watanabe, E., 3:25878
Fussell, J.B., *See* Burdick, G.R., 3:26221
Futch, A.H., *See* Damm, C.C., 3:27531
Fyfe, D., Statistical formulation of one-dimensional electron fluid turbulence, 3:27567

G

Gabrielse, G., *See* Berry, H.G., 3:27078
See Hight, R.D., 3:27075
Gadzhi-Kasumov, A.S., Character of distribution of naphthene acids in petroleums of lower Kura depression deposits, 3:25817
Gaertner, F.H., Catalytic and structural properties of the pentafunctional/arom/enzyme conjugate, 3:26944 (CONF-780108—1)
Gaertner, K., Studies on space dependence of the spectral density functions of neutron flux noise in pressurized water reactors, 3:26230
Galanti, M., *See* Maisonnier, C., 3:27496
Galichon, P., Chemical factors in in-situ uranium leach mining, 3:25914
Gallagher, W.R., *See* Duvel, W.A. Jr., 3:25680
Galonsky, A., *See* Johnson, C.H., 3:27361
Galumyan, P.I., *See* Abramyan, L.O., 3:27105
Galvin, T.M., *See* Wrona, B.J., 3:26313
Gamalij, E.G., *See* Afanas'ev, Yu.V., 3:27690
Gamble, T.D., Regulator for controlling liquid helium bath near 4.2 K, 3:26711
Gambs, G.C., Future market for LNG in the United States, 3:25848
Gangi, A.F., *See* Parrish, D.K., 3:26110
Garber, H.J., *See* Chapin, D.L., 3:27642
Garber, R., *See* Tanner, R.L., 3:26872
Garcia-Bermudez, G., *See* Ronningen, R.M., 3:27373
Garcia Velarde, M., Instabilities in fluid layers and in reaction-diffusion systems: Steady states, time-periodic solutions, non-periodic attractors, and related convective and otherwise non-linear phenomena, 3:27542 (JEN—379)
Gard, L.M. Jr., Geologic history, 3:27005 (TID—26712, pp 13-34)
Gardner, R.A., *See* Reid, M.S., 3:25984
Gardner, R.K., *See* Cocke, C.L., 3:27070
See Eck, J.S., 3:27344
See Gray, T.J., 3:27077
Garfield, D.A., *See* Eaton, R.A., 3:26554
Garfinkel, A.F., *See* Barish, S.J., 3:27116
See Whitmore, J., 3:27139
Gari, H.N., *See* Loehrke, R.O., 3:26080
Garkabii, A.P., *See* Egerev, V.V., 3:25972
Garrett, W.R., Rotational resonances in low-energy electron scattering by H_2 and D_2, 3:27071
Garton, W.R.S., *See* Fonck, R.J., 3:27048
Garvey, G.T., Physics Division annual review, 1 April 1976—31 March 1977, 3:27312 (ANL—77-60)
Gary, J.H., Clean solid and liquid fuels from coal. Quarterly progress report,

July—September 1977, 3:25665 (TID—28167)
Gast, K., Safety device in a nuclear reactor fuel rod with a closed fission gas plenum, 3:26327
Gastmans, R., Gauge theories: an introduction, 3:27295
See Levy, M., 3:27292
Gatley, J.A., *See* Bishop, J.F.W., 3:26294
Gatti, R.C., *See* Jaklevic, J.M., 3:26879
Gaucher, D.W., *See* Schott, J.R., 3:26920
Gaumer, L.S., *See* Chatterjee, N., 3:25838
Gawedzki, K., Geometric quantization: an extended procedure, 3:27411
Gay, C., *See* Scott-Monck, J., 3:25987
Gay, T., *See* Hight, R.D., 3:27075
Gee, D., *See* Ballagh, H.C., 3:27114
Geertsema, A., Hydrocarbon cracking on amorphous and zeolithic cracking catalysts, 3:25764 (NP—22646)
Geesaman, D.F., Fusion of $^{16}O + {}^{40}Ca$, 3:27350 (ANL—77-60, pp 39-40)
See Bowles, T., 3:27334
See Davids, C.N., 3:27355
See Tabor, S.L., 3:27340
Geffen, D.A., Solutions to a gauge-invariant, equal-time two-body wave equation. Light-mass quark-antiquark system, 3:27154
Gehring, W., KWU puts the emphasis on planning and control, 3:26237
Geiseler, H., Reflections on the assumption of pipe breaks in order to improve safety in nuclear power plants, 3:26464
Geiss, K., Protection of steel and zinc-alloyed steel in power plants with Goldschmidt-products, 3:26186
Geist, J.M., *See* Chatterjee, N., 3:25838
Gel'd, P.V., *See* Korshunov, I.G., 3:26615
Gell, Y., Effects of an ion beam on the motion of solitons in an ion beam-plasma system, 3:27576
Geller, R., Source of low energy neutrals (1 to 4kV) for the production of negative ions, 3:27652 (CEA-CONF—3864)
Genant, H.K., Bone-seeking radionuclides: an in vivo study of factors affecting skeletal uptake, 3:26972
Genoud, J.P., Determination of the 'transit' time between two cores by a noise analysis method, 3:26354
Genter, F.C., *See* Mullaney, P.F., 3:26961
Geogievskii, A.V., *See* Amelin, V.Z., 3:27606
George, J.F., Powerhouse intake gate catapult study, Big Bend Dam, South Dakota, and Stockton, Harry S. Truman, and Clarence Cannon Dams, Missouri. Hydraulic model investigation. Final report, December 1973—January 1976, 3:25979 (AD-A—043876)
Georgi, H., Clean tests of quantum chromodynamics in μp scattering, 3:27172
Natural stepwise breaking of gauge and discrete symmetries, 3:27151
Gerber, K.A., *See* Book, D.L., 3:27600
See Hammer, D.A., 3:27438
Gerking, E., Influence of method of cooling tower operation on plume length, 3:26137
Gershtein, S.S., Violation of scaling and the production of charmed particles in neutrino experiments, 3:27201
Gershuni, S.Sh., *See* Isaev, V.N., 3:25777
Gerver, M.J., Radial normal mode calculation of warm plasma stabilization of the drift cone mode, 3:27544
Gestryina, G.M., Kinetic theory of a resonance radiation of a magnetic plasma from an open periodic waveguide, 3:27581
Gethard, P.E., *See* Knell, E.W., 3:25654
Getty, W.D., *See* Bernabei, S., 3:27582
Ghosh, A.K., *See* Wiesmann, H., 3:26602
Gibbons, W., Snakes of the Savannah River Plant with information about snakebite prevention and treatment, 3:26894 (SRO-NERP—1)
Gibbs, M., Effect of light on respiration and development of photosynthetic cells. Progress report, June 1, 1976—August 31, 1977, 3:26969 (COO—3231-5)
Gibson, G., *See* Chapin, D.L., 3:27642
Gibson, G.H., *See* Eke, P.W.A., 3:25875
Gicquel, R., Method for evaluating the solar energy provided by a flat insolator, 3:26065
Giese, R., *See* Miller, D., 3:27131
Giguere, R.J., In situ recovery process for the oil sands of Alberta, 3:25898
Gil, H., Criterion for gas, coal and rock bursts, 3:25697
Gilbert, D., *See* Goddard, M.C., 3:27141
Gilbert, R.O., Initial synthesis of area 13 ^{239}Pu data and other statistical analyses, 3:26912 (NVO—171, pp 237-274)
See Romney, E.M., 3:26913
Gilchriese, M.G.D., Comparison of $K^{+-}N$ charge-exchange reactions at 8.5 and 13 GeV/c, 3:27138
Giles, G.E., HEATING5 analysis of a welding problem, 3:26594 (K/CSD/INF—77/17)
Giles, N.H., Studies on mechanisms of mutation, recombination, and gene action in neurospora. Final report, 3:26968 (SRO—735-5)
Gilles, A., New Invar membrane containment system for construction of LNG carriers, 3:25880
Gillette, D.A., *See* Porch, W.M., 3:26866
Gilman, J.D., Assessment of reactor internals vibration in BWR/4 and BWR/5 plants, 3:26207 (NEDO—24057)
Ginoux, J.J., *See* Buchlin, J.M., 3:26257
Girnius, R.J., Collisions of H^- ions and fast H^0 atoms in a Cs vapor target, 3:27068
Girshfel'd, V.Ya., *See* Borisov, G.M., 3:26170, 3:26175
Giusti, E.V., Water consumption by nuclear powerplants and some hydrological implications, 3:26413 (USGS-CIRC—745)
Gladd, N.T., *See* Davidson, R.C., 3:27549
Gladkii, A.V., *See* Govorov, V.V., 3:26787
Gladkikh, V.A., Determination of thermal stability of jet fuels under dynamic conditions, 3:25816
Gladkov, V.V., *See* Andreev, M.F., 3:27385
Glaeser, E., Chemical process measurements in PWR-type nuclear power plants, 3:26229
Glanzman, V.M., *See* Dudley, W.W. Jr., 3:26896
Glaser, P.E., Development of a satellite solar power station, 3:26031
Glasser, R.G., *See* Whitmore, J., 3:27139
Glendenning, N.K., Nuclear collisions at very high energy, 3:27147 (LBL—6597)
See Baltz, A.J., 3:27369
Glenn, R.D., Hanford critical radiation dosimeter, 3:26826 (PNL—2276)
Glickman, S.L., *See* Briefel, E., 3:27140
Glimm, J., Cluster expansions and their application to the n-particle structure of weakly coupled quantum field models, 3:27300
Glinka, C.J., Small-angle critical neutron scattering from cobalt, 3:26612
Glukhikh, V.A., Results of research into superconducting switches with high specific switching capacity, 3:27650 (LA-tr—78-13)
Selection of the superconducting current-carrying element for the "T-10M" installation, 3:27645 (LA-tr—78-10)
Glushchenko, N.F., Single-frequency garnet laser with a waveguide resonator, 3:26760
Goad, C.A., Clustering algorithm for mixtures of monotone densities, 3:26962 (LA—7120-MS)
Goans, R.E., *See* Parkinson, W.W. Jr., 3:26817
Gobbi, B., *See* Chaney, D., 3:27121
See Mollet, W., 3:27123
See Scharre, D.L., 3:27113
Goddard, M.C., Search for $\pi^+ p \rightarrow D\text{-}bar^0 C_1^{++}$ near threshold, 3:27141
Godfrey, A., Spherical containment system has many advantages, 3:26447
Godin, M., Hot air motors for thermal conversion of solar energy, 3:26057
Godridge, A.M., Development and use of a TV system for viewing flames, 3:26782
Gogitidze, I.D., *See* Kovalev, G.I., 3:25787
Goguel, R., *See* Naughton, J.J., 3:26123
Gohar, Y., *See* Avci, H.I., 3:27618
Goland, A.N., *See* Grand, P., 3:26791
Golay, M.W., *See* Best, F.R., 3:26338
Goldberg, H., Quantum chromodynamics predictions for the associated production of charm by neutrinos, 3:27186
Goldberg, M., *See* Briefel, E., 3:27140
Goldemberg, J., *See* de Vasconcelos Martins, J.M., 3:26056
Golden, J.O., *See* Gary, J.H., 3:25665
Goldenbaum, G.C., *See* Hammer, D.A., 3:27438
Goldhar, J., Injection-locked, narrow-band KrF discharge laser using an unstable resonator cavity, 3:26743
Goldman, S.B., *See* Best, F.R., 3:26338
Goldman, S.R., Plasma physics mechanisms relevant to striation structuring and decay. part 1 - aspects of striation decay. Part 2. A synopsis of drift mode behavior. Part 3. Velocity shear, the E x B instability and the k to the -2nd power density spectrum. Final report 22 December 1975—21 December 1976, 3:27482 (AD-A—043571)
Goldman, T., Limits on the mass of the muon neutrino in the absence of muon-lepton-number conservation, 3:27197
Radiative decays of fermions and the mass of the photon, 3:27178
Goldstein, B.R., *See* Barreto, F., 3:25662
Goldston, R.J., Magnetics design for ripple-assisted beam injection into the ISX-B and TFTR Tokamaks, 3:27592 (CONF-771029—203)
Golev, Yu.D., *See* Maklakova, V.P., 3:26158
Golin, M. Kahana, S.H., *See* Auerbach, E.H., 3:27338
Golovashkin, A.I., Thermomodulation spectra of the superconducting alloy $Nb_3(AlSi)$, 3:26626
Golovskii, E.A., Density of liquid propylene on the curves of coexistence liquid--vapor, liquid--solid, 3:25818
Golub, R., *See* Lanford, W.A., 3:27315
Golubev, G.V., Numerical method of determination of hydrodynamic conductibility of a nonhomogeneous oil-bearing stratum, 3:25750
Gonchar, v.K., Effect of thermal resistance of network water heaters on the operation of a t-250/300-240 turbine plant in variable conditions, 3:26179
Goncharov, V.V., Experimental water-water reactor, 3:26428
Good, W.M., *See* Parkinson, W.W. Jr., 3:26817
Goodlett, C.B., Concentration of aqueous radioactive waste with wiped-film evaporators, 3:25934
Goodman, A.S., *See* Cataldo, J.C., 3:26935

Goodman, R.K., *See* Damm, C.C., 3:27531
Goodspeed, R.H., *See* Batkin, A.R., 3:25853
Gorbanenko, A.D., *See* Krutiev, V.A., 3:26195
Gorbatov, A.M., *See* Bursak, A.V., 3:27387
Gordienko, V.V., Radiogenic heat flow from the upper mantle of continental regions, 3:26113
See Zavgorodnya, O.V., 3:26098
Gordon, G.M., Fuel element, 3:26401
Fuel element, 3:26402
Gordon, H.A., *See* Goddard, M.C., 3:27141
Gorechenkova, N.A., *See* Tsybulevskii, A.M., 3:25773
Gorman, M., Raman scattering from hybridized electronic levels in uniaxially stressed Ge(As), 3:26657
Gorobets, B.S., Investigation of uranium-1 and uranium-containing minerals by luminescence spectra, 3:25905
Gorokhov, V.P., *See* Amelin, V.Z., 3:27606
Goshaw, A.T., *See* Biswas, N.N., 3:27132
Gottardi, N., *See* Lisitano, G., 3:27491
Gottschalk, A., *See* Hoffer, P.B., 3:26973
Gottschalk, T., *See* Barger, V., 3:27188, 3:27189, 3:27195
Goubau, W.M., *See* Gamble, T.D., 3:26711
Goubin, Jean, *See* Cousyn, Rene, 3:26205
Gough, R.A., *See* Cerny, J., 3:26803
Goulard, B., Beta decays and related processes in the A = 14 nuclei, 3:27326
Goulding, F.S., *See* Jaklevic, J.M., 3:26879
Gourevitch, S.A., *See* Briefel, E., 3:27140
Gourlan, C., *See* Maisonnier, C., 3:27496
Govorov, V.V., Catalytic oxidation of calcium sulfite during removal of SO_2 from flue gases by the limestone method, 3:26787
Grader, R.J., Experimental determination of the angular distribution of transition radiation following photoeffect, 3:27060
Gradov, O.M., Induced radiation from a plasma cylinder, 3:27577
Gradstein, F.M., *See* Jansa, L.F., 3:25743
Graf, D.L., Concentration dependence of activation free energies in electrolyte diffusion (abstract), 3:26115
Graff, R.A., Improved techniques for gasifying coal. Fourth quarterly report, April 1—June 30, 1977, 3:25635 (FE—2340-4)
Graham, D.J., *See* Campbell, F.J., 3:25805
Grahan, C.L., Gamma-ray dosimetry errors with TLDs, 3:26827 (UCRL—80183)
Grahl, K.G., Contribution to calculate the performance of multistage axial-flow compressors, 3:26567
Current-state of off-design calculation methods for multistage axial-flow compressors, 3:26568
Gram, P.A.M., Effect of an electric field upon resonances in the H^- ion, 3:27058
Grand, P., Intense neutron source based upon the deuterium-stripping reaction, 3:26791
Granoff, B., Effects of mineral matter on the hydroliquefaction of coal, 3:25663 (SAND—77-1558C)
See Thomas, M.G., 3:25664
Grant, D.M., *See* Franz, J.A., 3:25669
See Hamill, W.D., 3:26686
Grant, E.R., Is multiphoton dissociation of molecules a statistical thermal process, 3:27047
See Sudbo, A.S., 3:27046
Grantham, R.S., *See* Ronningen, R.M., 3:27374
Grasberger, W.H., *See* Jensen, R.V., 3:27627
Gratton, F., Magnetic tension and thickness in the current sheath dynamics, 3:27495
See Vargas, M., 3:27485
Gratton, J., *See* Vargas, M., 3:27485
Gratton, R., *See* Bruzzone, H., 3:27493
Grauby, A., Agricultural use of heat discharge by nuclear power plants, 3:26420
Gray, D., Infrared television measurement of heliostat images, 3:26075
Gray, T.J., Role of K-shell vacancies in determining charge-state fractions for heavy ions emerging from solids, 3:27077
See Eck, J.S., 3:27344
Grebenik, A.M., *See* Shpak, V.S., 3:26361
Green, B.J., Local, ideal and resistive stability in tokamaks with non-circular cross-section, 3:27557
Green, C.E., Event dice throw, mobility experiments. Final report, 3:26858 (AD-A—046146)
Green, J.L., *See* Bauer, A.A., 3:26306
Green, N.W., *See* Knell, E.W., 3:25654
Green, R.M., *See* Nichols, M.C., 3:26483
Greenberg, V.A., *See* Naughton, J.J., 3:26123
Greene, M.R., Management of social and economic impacts associated with the construction of large-scale projects: experiences from the Western coal development communities, 3:26496 (BNWL-RAP—16)
Greenfield, M., *See* Swenson, L.W., 3:27342
Greenlees, G.W., *See* Fitzgerald, D.H., 3:27365
Greenwood, C.W., Partial oxidation of fuel oil route to methanol production, 3:25966
Gregor, H.P., Current status of an ERDA project "permselective membrance control of algal and wood digesters for increased production and chemicals recovery", 3:26009 (COO/2991—19, pp 45-46)
Gregory, D.P., Prospects for the use of hydrogen as an energy carrier, 3:25963 (CONF-771039—10)
Greifinger, C., Effect of a cylindrically-symmetric ionospheric disturbance on elf propagation in the earth-ionosphere waveguide. Topical report, 3:27043 (AD-A—046237)
Greifinger, P., *See* Greifinger, C., 3:27043
Greiner, D.E., *See* Lindstrom, P.J., 3:27122
Grek, B., Non-linear interaction of intense CO_2 radiation with dense plasma, 3:27686
Grenz, G., *See* Friedrich, G., 3:26461
Gribble, R.F., *See* Butt, E.P., 3:27631
Griem, H.R., *See* Datla, R.U., 3:27471
Griffin, P.M., *See* Pegg, D.J., 3:27080
Griffith, W.L., *See* Pitt, W.W. Jr., 3:26011
Grigorov, N.L., Effect of the rise of the inelastic interaction cross section on the form of the energy spectrum of cosmic-ray hadrons, 3:27134
Grigoryan, L.A., Eikonal and quasi-eikonal models in the theory of complex angular momenta for pion elastic scattering and rho^0-meson photoproduction on ^{4}He nuclei, 3:27235
Grimes, S.M., *See* Fitzgerald, D.H., 3:27365
Grinchishin, Y.T., Single W-meson production in the scattering of hadrons in the Coulomb field of nuclei, 3:27234
Grisaru, M.T., *See* Abbott, L.F., 3:27243, 3:27244
Gritzmann, P.G., *See* Farfaletti-Casali, F., 3:27599
Grivaz, J., *See* Ballagh, H.C., 3:27114
Grizinski, T., *See* Prettie, C., 3:27041
Grolmes, M.A., Advanced fuels safety comparisons, 3:26477
See Holtz, R.E., 3:26432
Gromov, N.K., Principles of arrangements of heating networks in towns, their automation, and remote control, 3:26549
Gronskii, R.K., *See* Maklakova, V.P., 3:26158
Grosjean, D.F., *See* Olson, R.A., 3:26715
Gross, D.J., *See* Callan, C.G. Jr., 3:27158
Gross, R.W.F., *See* Turner, E.B., 3:26717
Grossaint, K.J., *See* Turbett, J.R., 3:26839
Grossman, L.W., *See* Hurst, G.S., 3:27062
Grotloh, Kh., Back pressure: tight main steam isolating valves for PWRs, 3:26234
Gruber, H.E., Ultrastructural characteristics of advanced radiation-induced adenocarcinoma in the small intestine of the rat, 3:26986 (CONF-770504—, pp 16-23)
Gruber, R., *See* Berger, D., 3:27520
Gruenwald, J.T., *See* Fischbach, E., 3:27200
Gruhn, C.R., Jupiter energetic particle experiment ESAD proton sensor design, 3:26818 (LA—7009-MS)
Gryaznov, A.P., *See* Radchenko, E.D., 3:25771
Gudzenko, V.S., *See* Burgvits, G.A., 3:26140
Guenin, M., Short review of methods used to compute bound states, 3:27167
Guerra, F., Euclidean quantum field theory, 3:27301
Guest, G.E., *See* Hedrick, C.L., 3:27605
Guest, R.W., *See* Jewell, W.J., 3:26010
Guharay, S.K., Breakdown characteristics in presence of steady transverse magnetic fields, 3:27499
Guildner, L.A., Vapor pressure of water at its triple point: highly accurate value, 3:26116
Guillermin, R., *See* Grauby, A., 3:26420
Gun, R.B., Influence of air input rate on oxidation of residuum in the presence of ferric chloride, 3:25789
Gundtoft, H.E., Experience with a new ultrasonic inspection system for non-destructive examination of precision tubes, 3:26388
Gundyrev, A.A., Influence of alcohols on urea-adduct formation with solid paraffins, 3:25779
Gunion, J.F., *See* Brodsky, S.J., 3:27119
Gunkel, W.W., *See* Jewell, W.J., 3:26010
Gupta, A.K., Equivalent modal response method for seismic design of structures, 3:26454
Probable simultaneous response by the response spectrum method of analysis, 3:26455
Gupta, S.N., *See* Guharay, S.K., 3:27499
Guralnik, G.S., *See* Bender, C.M., 3:27272
See Feldman, D., 3:27146
Gureev, K.G., *See* Vikhrev, V.V., 3:27517
Gurev, H.S., Optical properties of thin film refractory metals, 3:26069
Gurvich, I.I., Dynamic range of reflection recording in seismic exploration, 3:27011
Gurvitch, M., *See* Wiesmann, H., 3:26602
Gus'kov, Y.K., Time-of-flight spectrometer measurements of elastic-scattering cross sections for electrons with energies of 0.04—1.5 eV in He and Ne, 3:27081
Gus'kov, Yu.K., Volt-ampere characteristics of thermionic converters in the diffusion regime with Coulomb collisions, 3:26541
Guseinov, E.A., *See* Melik-Akhnazarov, T.Kh., 3:25778
Gusev, M.E., Differential electro-optical shutter, 3:26752
Gutek, A.M.H., *See* Scotland, W.A., 3:25814
Guth, A.H., *See* Bernard, C.W., 3:27242
Guthrie, D.H., *See* Corbett, J.D., 3:26677
Gutmann, H., Muelheim—Kaerlich nuclear power plant, 3:26245
Gutorov, V.F., *See* Avrutskii, G.D., 3:26172
Guttman, L., *See* Ching, W.Y., 3:26644
Guzdar, A.R., *See* Rothchild, R.D., 3:25694

Gyurkocza, Cs., *See* Bereznai, T., 3:26249
Gyuzalyan, R.N., Picosecond source of coherent optical radiation tunable over the 350 to 680 nm range of wavelengths, 3:26756

H

Haack, G., Cadmium stannate selective optical films for solar energy applications. Semi-annual progress report 1 Jan—30 Jun 75, 3:25994 (PB—273038)
Haas, R.A., Interaction of 1.06-μm laser radiation with planar targets, 3:27448
Haas, W.J. Jr., *See* Winge, R.K., 3:26664
Habercom, G.E. Jr, Offshore structures (a bibliography with abstracts). Report for 1964—July 1977, 3:26783 (NTIS/PS—77/0716)
Supertankers and superports (citations from the NTIS data base). Report for 1964—July 1977, 3:25807 (NTIS/PS—77/0700)
Supertankers and superports (citations from the Engineering Index data base). Report for 1970—July 1977, 3:25808 (NTIS/PS—77/0701)
Haberstroh, R.D., *See* Loehrke, R.O., 3:26080
Hackett, C.D., *See* Savor, D.E., 3:26379
Hackstein, K., Pyrocarbon-coated fuel particles for fuel elements of HTR reactors, 3:26264
Haddenhorst, H.G., Studies on the storage of LNG in salt cavities, 3:25887
Haden, C.R., Regional power systems planning: a state of the art assessment. Interim report, survey of planning models, 3:26524 (ORO/5468—1)
Haenel, R., Geothermal energy from salt domes, 3:26082 (NP—23044)
Report on the development of geothermal energy, 3:26081 (NP—23047)
Temperature/depth distribution in the Federal Republic of Germany, 3:26087 (NP—23046)
Haferkamp, D., Pipe connection for high pressure and temperature loads, 3:26382
Hagen, C.R., Comments on a paper by Callan, Coote, and Gross, 3:27265
Demise of light cone field theory, 3:27291
Hagen, H.G., Screwing and holding device for lock nuts, especially for screwed joints of reactor pressure vessels, 3:26369
Hagenson, R.L., *See* Krakowski, R.A., 3:27454
Hagerman, D.C., *See* Fisher, T.R., 3:27375
Hagiwara, T., Newly found resonance Y (9.5) and the charge of the heavy quark, 3:27148
Haglund, R.F. Jr., Analyzing-power measurements for the ^{3}He(t,d)^{4}He reaction, 3:27324
Hagopian, S., *See* Bogert, D., 3:27145
Hagstrom, R., *See* Lindstrom, P.J., 3:27122
Hahn, Y., Distorted-wave theory of electron-ion collisions. I. Direct excitation and ionization, 3:27079
Haidlen, F., Reactor building for a nuclear reactor, 3:26479
Haimson, B.C., Effect of principal stress magnitudes on hydrofracturing orientation. Final report, 3:27014 (UCRL—13795)
Hakoda, K., *See* Takeda, S., 3:27595
Haldy, P.A., Moment method for calculating the transport of energetic charged particles in hot plasmas, 3:27522
Haley, D.R., *See* Finch, T.E., 3:25692
Hall, J.N., *See* Cisneros, E.L, 3:26831
Halliday, W.H., Iodine laser. Master's thesis, 3:26718 (AD-A—042289)
Halliwell, C., Energy dependence of the pseudorapidity distributions in proton-nucleus collisions between 50 and 200 GeV/c, 3:27124
Review of hadron—nucleus interactions at high energy, 3:27226 (COO—3069-556)
Halpern, I., *See* Fisher, T.R., 3:27375
Halpern, M.B., Field theories in terms of particle-string variables: Spin, internal symmetries, and arbitrary dimension, 3:27274
Gauge-invariant formulation of the self-dual sector, 3:27261
Particle limit of field theory: A new strong-coupling expansion, 3:27275
Halprin, A., *See* Fischbach, E., 3:27200
Hamann, H., *See* Gerking, E., 3:26137
Hamasaki, S., *See* Davidson, R.C., 3:27549
Hamby, D.C., Research on alkaline zinc secondary electrodes with emphasis on life improvement. Annual progress report, June 15, 1976—March 15, 1977, 3:26490 (RLO/2434—1)
Hamill, W.D., Carbon magnetic resonance spectroscopy on carbon-13-labeled uracil in 5S ribonucleic acid, 3:26686
Hamilton, J.H., *See* Cole, J.D., 3:27370
See Collins, W.E., 3:27371
See Robinson, R.L., 3:27358
See Ronningen, R.M., 3:27373, 3:27374
Hamlin, D.A., ROSCOE manual. Volume 16. High-altitude neutral-particle motion. Final report, 1 March 1974—31 January 1975, 3:27039 (AD-A—043546)
ROSCOE manual. Volume 17. High-altitude debris-energy deposition. Final report, 1 March 1974—31 January 1975, 3:27040 (AD-A—043547)
Hamman, J.P., *See* Seliger, H.H., 3:26946
Hammer, D.A., Intense relativistic electron beam interaction with a cool theta pinch plasma, 3:27438
See Book, D.L., 3:27600
Hammond, P.R., *See* Henry, R.A., 3:26720
Hamond, C.F., *See* Marsh, S.F., 3:26665
Hamstad, M.A., Structural integrity of fiber/epoxy vessels by acoustic emission, 3:26708
Handler, R., *See* Heller, K., 3:27129
Hanes, M.H., *See* Hopkins, R.H., 3:25990
Hanft, R., *See* Bogert, D., 3:27145
Hangelbroek, R.J., Collocation methods for integro-differential equations, 3:27713
Hanlon, J., *See* Lys, J.E.A., 3:27126
Hanna, I., Device for measuring the position of control rods in nuclear reactors, 3:26410
Hansen, H.R., *See* Solberg, D.M., 3:25843
Hansen, K.M., *See* Mullaney, P.F., 3:26961
Hansen, L.F., Laser driven fusion fission hybrids, 3:27681 (UCRL—79653(Rev.1))
Hanson, C.L., *See* Booth, R., 3:26789
Hanson, D.L., *See* Stokstad, R.G., 3:27336
Hanson, G., *See* Scharre, D.L., 3:27113
Hanson, G.G., $e^+ e^-$ hadron production and jet structure at SPEAR, 3:27171 (SLAC-PUB—1814)
Hanson, K.M., *See* Bebek, C.J., 3:27104
Hanson, M.E., *See* McKee, C.R., 3:25702
Harari, H., Three generations of quarks and leptons, 3:27240 (SLAC-PUB—1974)
Harayama, Y., *See* Yamada, R., 3:26387
Hardekopf, R.A., *See* Haglund, R.F. Jr., 3:27324
Hardie, G., *See* Meyer-Schuetzmeister, L., 3:27347
Hargrove, O.W., *See* Corbett, W.E., 3:25679
Harmon, B.N., Electron-phonon spectral function and mass enhancement of niobium, 3:26611
Harmon, S.A., *See* Hamill, W.D., 3:26686
Harper, P.V., *See* Genant, H.K., 3:26972
Harris, F.A., *See* Ballagh, H.C., 3:27114
Harris, R., *See* Bogert, D., 3:27145
Harris, S.E., *See* Byer, R.L., 3:26732
Harrison, E.A., Ecosystem models. Volume 2. November 1975—November 1977 (a bibliography with abstracts), 3:26990 (NTIS/PS—77/1011)
Harte, J., Ponderomotive force in a hydrodynamic simulation code, 3:27093 (UCRL—79860)
Hartman, C.W., Conceptual fusion reactor based on the high-plasma-density Z-pinch, 3:27604
Hartner, G., *See* Biswas, N.N., 3:27132
Harvey, E.H., *See* Whitmore, J., 3:27139
Hasegawa, I., *See* Ogawa, K., 3:26095
Haselbacher, H., Nitrogen gas turbines for LNG regasification, 3:25840
Haselman, L.C., Theoretical model for two-phase fuel injection in stratified charge engines, 3:26588 (UCRL—79534)
Hashimoto, A.G., Anaerobic fermentation of animal and crop residues: summary. Quarterly progress report (second), April 1, 1977—June 10, 1977, 3:26017 (COO/2991—19, pp 99-110)
Hasmim, A., Algerian perspective on maritime transport of LNG, 3:25871
Hasni, T., *See* Khenat, B., 3:25837
Hassner, D.Z., *See* DeFrees, D.J., 3:26691
Hastie, R.J., Ballooning instabilities in toroidally linked mirror systems, 3:27558
Hatcher, C.W., *See* Johnson, W.L., 3:27682
Hathaway, S.A., Technology evaluation of Army-scale waste-to-energy systems, 3:25973 (AD-A—042578)
Hatta, M., *See* Ball, S.J., 3:26255
Hauer, A., *See* Yaakobi, B., 3:27474
Hauer, C.R., *See* Bezdek, R.H., 3:26047
Hawryluk, R.J., *See* Suckewer, S., 3:27436
Hayase, K., *See* Takeda, S., 3:27595
Hayashi, K., *See* Hori, K., 3:26781
Hayashi, T., *See* Fukui, K., 3:25809
Haynes, W.M., Densities of LNG for custody transfer, 3:25881
Hayns, M.R., *See* Bellamy, R.G., 3:26317
Hays, P., *See* Bogert, D., 3:27145
Hazi, A.U., Theoretical study of the photoionization of metastable neon, 3:27050
See Rescigno, T.N., 3:27073
Heald, M.A., *See* Bernabei, S., 3:27582
Healy, J., Heat treatment of organics for increasing anaerobic biodegradability. Quarterly progress report, March 1, 1977—May 31, 1977, 3:26007 (COO/2991—19, pp 7-16)
Hebert, J.A., *See* Maynard, W.S., 3:25935
Hecker, R., Survey on experimental neutron physics of CTR blankets in the KFA, 3:27610 (EUR—5602, pp 551-556)
Heckman, H.H., *See* Lindstrom, P.J., 3:27122
Hedrick, C.L., Simple neoclassical point model for transport and scaling in EBT, 3:27605
Hedrick, R.A., *See* Clemons, V.D., 3:26440
Hedstrom, J.C., *See* Balcomb, J.D., 3:26052
Hehre, W.J., *See* DeFrees, D.J., 3:26691
Heidger, P.M. Jr., *See* Herr, J.C., 3:26955
Hein, K., Unit-type power stations as elements for district heating. Principle: Heat-power coupling is systematically utilized, 3:26187
Heinken, G., Identification of eruption clouds with the Landsat satellites, 3:26089
Heinrich, R.A., Electric power from containers, 3:26181

Helbert, J.N., Radiation degradation susceptibility of several related polymers. Research and development technical report, 3:26693 (AD-A—042525)
Held, J.L., *See* Booth, R., 3:26789
Helf, H., *See* Schabert, H.P., 3:26253
Heller, H., Bayer process for the manufacture of maleic anhydride from butenes and as a by-product of the phthalic anhydride production, 3:25786
Heller, K., Inclusive production of Λ^0 hyperons by 300-GeV protons: A dependence, 3:27129
Heller, P., *See* Lynn, J.W., 3:26652
Helm, W.T., *See* Valdez, R.A., 3:26924
Hemingway, R.J., *See* Briefel, E., 3:27140
Hemmendinger, A., *See* Veeser, L.R., 3:26819
Hemmings, P.L., Thermodynamic phase stability diagrams for the analysis of corrosion reactions in coal gasification/combustion atmospheres. Interim report, 3:25626 (EPRI-FP—539)
Hempelmann, W., Plant for decanting strongly radioactive resins in waste containers, 3:25924
Hemphill, R.N., *See* Pelletier, C.A., 3:26356
Henderson, R.W., *See* Vasilik, D.G., 3:26888
Hendrick, R.E., *See* Cutkosky, R.E., 3:27225
See Engelmann, T.R., 3:27224
Hendricks, C.D., *See* Johnson, W.L., 3:27682
Hendrickson, C.P., *See* Crowley, W.P., 3:26770
Henesian, M.A., *See* Byer, R.L., 3:26669
Henning, W., *See* Geesaman, D.F., 3:27350
See Rehm, K.E., 3:27352
See Tabor, S.L., 3:27340
Hennion, F., New developments of the data acquisition system of TFR, 3:27695 (EUR—5602, pp 505-509)
Henrikson, H.E., *See* Cheung, N.K., 3:27348
Henry, R.A., Synthesis of the laser dyes, AC2F and AC3F, and related compounds. Research report, July—September 1976 and April—May 1977, 3:26720 (AD-A—042344)
Henry, R.J.W., *See* Robb, W.D., 3:27074
Henyey, F.S., Singular pseudoparticles in Higgs theories, 3:27156
Hepworth, H., Experience with instrument systems on North Sea oil and gas production platforms, 3:25748
Herley, P.J., Effects of γ-ray radiation on the thermal decomposition of lithium aluminum hydride powder, 3:26697
Herr, J.C., Decidual cell secretion, a unique mode of exocytosis, 3:26955 (CONF-770504—, pp 88-94)
Herrera, A.J., M6 steam drive project design and implementation, 3:25751
Herrera, G., *See* Fujita, T., 3:26038
Herrera, J., *See* Ferbel, T., 3:26809
Herrmann, C.R., *See* Ingram, G.E., 3:26435
Herzog, M., Stress of structures caused by earthquakes according to calculation and measurement, 3:26469
Hetyei, S.A., Dynamic models of falling film evaporators for ocean thermal energy conversion plants, 3:26040 (COO/2641—3)
Heusch, C.A., *See* del Papa, C., 3:27102
Heusden, R. van, *See* Burn, K., 3:27609
Heusse, P., *See* Jonckheere, A.M., 3:27144
Hibbs, F.M., Some recent trends and advances in petrochemical technology, 3:25766
Hickman, A.P., *See* Smith, F.T., 3:27033
Hickok, W.W., Coal Creek Station steam generators, 3:26130 (GFERC/IC—77/1, pp 43-73)
Hicks, J.B., *See* Bertolini, E., 3:27646
Hidaka, H., *See* Ueda, K., 3:25884
Hiebert, R.D., *See* Bartholdi, M., 3:26823
See Mullaney, P.F., 3:26961
Hietarinta, J., Chiral properties of the fermionic determinant in quantum chromodynamics, 3:27245
Higbie, P.R., *See* Gruhn, C.R., 3:26818
Higgins, J.A., *See* Barrnett, R.J., 3:26953
Higgins, J.H., *See* Kursh, S.J., 3:26053
Higgins, P.D., *See* Biswas, N.N., 3:27132
Higgins, W.H., *See* Bevilacqua, F., 3:26236
Hight, R.D., Alignment of helium excited by thin carbon foils, 3:27075
Hilbert, R.F., *See* Cox, C.M., 3:26303
Hildebrandt, E., Device for ultrasonic material testing of bolts having an axial through hole, preferably stud bolts of nuclear reactor pressure vessels, 3:26385
Hill, D., *See* Miller, D., 3:27131
Hill, D.G., *See* Whitmore, J., 3:27139
Hill, E.R., Calculation of population distribution using a computer data base, 3:26939 (BNWL—2395)
Hill, M.D., Hazard associated with vitrified high-level radioactive waste, 3:25941
Hill, R.F., ESCOE engineering program. Quarterly report, September 1—November 30, 1977, 3:25638 (FE—2468-18)
Hill, R.H., *See* Wright, M.D., 3:26712
Hindin, S.G., Catalyst development for coal liquefaction. Annual report, July 1, 1976—June 30, 1977, 3:25657 (FE—2335-13)
Catalyst development for coal liquefaction. Interim report, July—September 1977, 3:25658 (FE—2335-16)
Hindle, W., Arctic islands LNG, 3:25872
Hinnov, E., *See* Suckewer, S., 3:27478
Hirakawa, S., Contribution of the Export—Import Bank of Japan to Japanese LNG projects, 3:25854
Japan's energy policy and role of LNG, 3:25850
Hirano, T., *See* Tajima, Y., 3:26104
Hirano, Y., *See* Takeda, S., 3:27595
Hirota, I., *See* Takeda, S., 3:27595
Hirshfield, J.L., *See* Chu, K.R., 3:27546
Hirshman, S.P., Moment equation approach to neoclassical transport theory, 3:27511
Hitchcock, D.A., *See* Brecht, S.H., 3:27545
Hively, L.M., Fusion product bombardment of a tokamak first wall, 3:27626
Hiza, M.J., *See* Haynes, W.M., 3:25881
Ho, T.L., Direct synthesis of anilides from nitroarenes, 3:26687
Hodson, S.W., *See* Deupree, R.G., 3:27023
Hodzic, A., *See* Haferkamp, D., 3:26382
Hoffer, P.B., Tumor scanning agents, 3:26973
Hoffman, A.L., Laser heating of magnetically confined plasmas for x-ray production. Final report on phase 3, 3:27481 (AD-A—043486)
See Krakowski, R.A., 3:27454
Hoffman, E.J., *See* Phelps, M.E., 3:26993
Hoffman, G.E., *See* Knigge, K.M., 3:26983
Hoffman, M., *See* Hartman, C.W., 3:27604
Hoffman, M.A., Research on the wetted first wall concept for future laser fusion reactors. Final report No. 2, February 1, 1976—August 31, 1977, 3:27672 (UCRL—13677-3)
See Bertolini, E., 3:27624
Hoffman, T.J., Calculation of the reactivity due to bubble collapse with the probability table method, 3:26283 (ORNL/CSD/TM—35)
Hoffmann, A., *See* Bourrier, P., 3:27694
Hoffmann, F., *See* Sassin, W., 3:25721
Hoffnayle, G., *See* Murphy, B., 3:26193
Hofmann, F., *See* Berger, D., 3:27520
Hokenson, G.J., Boundary-layer blockage with mass transfer, 3:27094
Holland, R.E., *See* Elwyn, A.J., 3:27337
Hollander, H.I., Processed refuse: a salvage fuel for existing boilers, 3:25974
Hollenack, W.R., *See* Lewis, H.E., 3:25648
Hollis, A., *See* Mitchell, J.T.D., 3:27699
Holman, G.B., *See* Fast, C.R., 3:25861
Holmes, J.C., *See* Szuszczewicz, E.P., 3:27036
Holmes, R.A. Jr, *See* Moffitt, R.L., 3:25882
Holmgren, D., *See* Jonckheere, A.M., 3:27144
Holstein, B.R., Tests of spontaneous left-right—symmetry breaking, 3:27252
Holt, R.J., *See* Bowles, T., 3:27334
See Laszewski, R.M., 3:27331, 3:27376
Holtz, R.E., Final report on TREAT Test R3, a single-pin loss-of-flow experiment, 3:26432 (ANL—77-54)
Holzrichter, J.F., Solid-state laser program, 3:27676 (UCRL—52000-77-8, pp 13-22)
Homann, S.G., *See* Grahan, C.L., 3:26827
Hong, S.O., *See* Michaelson, P.F., 3:27640
Honzawa, T., *See* Matsumoto, A., 3:27656
Hooie, D.T., *See* Schorr, J.R., 3:26882
Hooke, W.M., *See* Bernabei, S., 3:27582
Hooks, H.W., *See* Lewis, H.E., 3:25648
Hooper, E.B. Jr., *See* Berkner, K.H., 3:27658
Hopkins, R.H., Silicon materials task of the low cost solar array project (Phase II). Seventh quarterly report, April 1, 1977—June 31, 1977, 3:25990 (ERDA/JPL/954331—77/3)
Hoppe, R., *See* Batey, J., 3:26777
Hori, K., Experimental studies on fluidized-bed combustion (1st report), 3:26781
Studies on nitrogen oxides removal from flue gas (No. 2), 3:26196
See Ozaki, K., 3:26569
Horie, T., *See* Okano, T., 3:26951
Horn, E.A., *See* Glukhikh, V.A., 3:27645
Hornady, R.S., *See* Damm, C.C., 3:27531
Horst, T.W., Estimation of air concentrations due to the diffusion, deposition and resuspension of contaminants by the wind, 3:26883 (PNL—2426)
Horton, W. Jr., *See* Brecht, S.H., 3:27545
Hosegood, S.B., *See* Rennie, C.A., 3:26266
Hoshino, K., *See* Inoue, N., 3:27453
Hoskins, A.J., *See* Worsnop, P.A., 3:27596, 3:27596
Hospe, J., Energy from nuclear reactors. Pt. 3. The functioning of nuclear power plants with BWR reactors, 3:26218
Energy from nuclear reactors. Water as moderator: LWR reactors prevail. Pt. 1, 3:26219
Energy from nuclear reactors. Pt. 2. The functioning of nuclear power plants with PWR reactors, 3:26244
Energy from nuclear reactors. Pt. 8. Two coal gasification procedures using reactor heat - 70% conversion efficiency, 3:26260
Energy from nuclear reactors. Pt. 7. The gas breeder has some advantages: thorium as a fuel, 3:26290
Energy from nuclear reactors. Pt. 4. The fast breeder: better utilization of uranium, 3:26291
Energy from nuclear reactors. Pt. 6. The gas-cooled HTR: reactivation of coal, 3:26340
Energy from nuclear reactors. Pt. 5. Fast breeder reactor safety, 3:26468
Houlberg, W.A., *See* Peng, Y.K.M., 3:27637
Hourst, J.B., 160 kV, 200 mA dc accelerator for high 14 MeV neutron yield, 3:26792
Howard, J.B., *See* Bush, T.W., 3:25619

Howard, W.A., *See* White, M.G., 3:26909
Howington, L.C., Development of an aging integrator for uranium-0.75 weight percent titanium alloy part aging control, 3:26595 (Y—2101)
Hoyt, E.W., *See* Dean, N.R., 3:26815
Hryniszak, W., *See* Bainbridge, G.R., 3:26256
Hrynkiewicz, A., Nuclear physics and investigations with multiply charged ions, 3:27316
Hsu, J.P., *See* Chiu, C.B., 3:27406
Huang, K., Angular momentum in non-Abelian gauge field theories, 3:27290
Huang, S.C., *See* Phelps, M.E., 3:26993
Huba, J., *See* Davidson, R.C., 3:27549
Huber, D.A., Evaluation of a pressurized-fluidized bed combustion (PFBC) combined cycle power plant conceptual design. Quarterly report, July 1—September 30, 1977, 3:26143 (FE—2371-20)
Hubert, W.E., *See* Wolff, P.M., 3:26041
Hucklesby, R.J., Design aspects of a large toroidal stabilizing shell and vacuum liner assembly, 3:27696 (EUR—5602, pp 293-298)
Hudson, C.R. II, User's instructions for preliminary version of the CONCEPT-5 computer code, 3:26190 (ORNL/TM—6230)
Huff, D.D., *See* Munro, J.K., 3:27003
Hughes, M.H., Numerical calculations of transport in ALCATOR, 3:27507 (PPPL—1411)
Hughes, T.H., *See* Deitrich, L.W., 3:26431
Hugill, J., *See* Fielding, S.J., 3:27625
Hui, B., *See* Papadopoulos, K., 3:27524
Hui, B.H., *See* Davidson, R.C., 3:27549
Humpert, B., Neutral heavy leptons and e^+e^- colliding—beam experiments, 3:27193
Humphrey, J.W., 20 GeV e^+ x 400 GeV p: some synchrotron radiation considerations, 3:26805 (BNL—23533)
Exotic 4π detector for ISABELLE, 3:26806 (BNL—23534)
Prosaic use of stochastic cooling at ISABELLE, 3:26804 (BNL—23532)
Hundemann, A.S., Combined cycle power generation (citations from the NTIS data base). Report for 1964-Oct 77, 3:26147 (NTIS/PS—77/0991)
Combined cycle power generation (citations from the Engineering Index data base). Report for 1970-Oct 77, 3:26148 (NTIS/PS—77/0992)
Cooling towers (citations from the NTIS data base). Report for 1964—August 1977, 3:26131 (NTIS/PS—77/0804)
Cooling towers: design and performance (citations from the Engineering Index Data Base). Report for 1970—August 1977, 3:26132 (NTIS/PS—77/0805)
Cooling towers: environmental studies (citations from the Engineering Index Data Base). Report for 1970—August 1977, 3:26133 (NTIS/PS—77/0806)
Strip mining. Volume I. 1964-1975 (citations from the NTIS data base). Report for 1964—75, 3:26918 (NTIS/PS—77/0950)
Strip mining. Volume 2. 1976-October 1977 (citations from the NTIS data base). Report for 1976-Oct 77, 3:26919 (NTIS/PS—77/0951)
Hung, J.B., *See* Agarwala, U., 3:26699
Hunn, B.D., ERDA facilities solar design handbook, 3:26050 (LA-UR—77-186)
Hunsaker, B., Alternatives to LNG in the United States, 3:26513
Hunt, B.R., *See* Trussell, H.J., 3:27705
Hunt, R.W., Use of borehole geophysical methods in determining in situ bulk densities and water contents in unconsolidated materials. Final report, 3:26844 (AD-A—046114)
Hunter, D.I., *See* Turbett, J.R., 3:26839
Hurst, G.S., Selective single atom detection in a 10^{19} atom background, 3:27062
Hurt, S.S. III, Oak Ridge Research Reactor quarterly report, April, May, and June of 1977, 3:26423 (ORNL/TM—6200)
Huschka, H., Method and device for coating of particles, containing fissile, fertile or absorber material, used for HTR fuel elements, 3:26270
Huson, F.R., *See* Bogert, D., 3:27145
Huszar, L., Energy dependent air/ground correction factors for the ATR (air transport of radiation) code. Final report, 3:27400 (AD-A—043807)
Hutchinson, D.P., *See* Gilchriese, M.G.D., 3:27138
Hutchinson, I.H., Electron cyclotron emission in ALCATOR tokamak, 3:27497
Hyer, F.K., *See* Konya, M.J., 3:26228
Hyman, H., *See* Trainor, D., 3:26716
Hyman, L.G., *See* Barish, S.J., 3:27116
Hynds, J.A., *See* Johnson, A.C., 3:26522

I

Ichikawa, M., *See* Watanabe, H., 3:26311
Ichikawa, Y.H., Contribution of the second order terms to the nonlinear shallow water waves, 3:27565 (IPPJ—253)
Ichimura, M., *See* Inoue, N., 3:27453
Idmtal, J., *See* Hennion, F., 3:27695
Igarashi, A., *See* Takami, K., 3:25784
Igitkhanov, Yu.L., *See* Volkov, T.F., 3:27518
Iimoto, K., *See* Tanaka, S., 3:25867
Ijaz, M.A., *See* Cole, J.D., 3:27370
Ikeda, N., *See* Takeda, S., 3:27595
Il'inskii, S.E., *See* Demirkhanov, R.A., 3:27452
Il'kevich, Z.A., *See* Savin, V.I., 3:26545
Il'lna, I.L., Coherent excitation of nuclei and atoms on passing through a crystal. Effect of slowing down, 3:27402
Ilyukhin, A.A., Concerning the problem of lasers for the far ultraviolet $\lambda \sim 500$—700 A, 3:26749
Imai, T., Numerical studies of lower hybrid wave propagation in JFT-2, 3:27566 (JAERI-M—6902)
Ingram, B.S., *See* Worsnop, P.A., 3:27596
Ingram, F.D., Gross distortions in freeze-dried tissue preparations, 3:26956 (CONF-770504—, pp 129-134)
Ingram, G.E., Structural reliability methodology: application at the system level, 3:26435 (GEFR-SP—049)
See Crellin, G.L., 3:26357
Ingram, M.J., *See* Ingram, F.D., 3:26956
Inoue, N., Rapid further heating of tokamak plasma by fast-rising magnetic pulse, 3:27453
Inoue, S., *See* Ozaki, K., 3:25618
Inquimbert, R., *See* Montet, A., 3:25873
Interess, E., *See* LaMantia, C.R., 3:25678
Ioffe, B.L., *See* Boreskov, K.G., 3:27181
Iokhel'son, Z.M., *See* Vainshtein, Yu.D., 3:25725
Ione, K.G., *See* Miner, R.S. Jr., 3:26684
Irani, A.A., *See* Mobley, R.M., 3:26795
Iremashvili, D.V., Transportation of relativistic electron beam in a plasma, 3:27486
Irwin, J.L., HPBN development, 3:26632 (SAND—782076C)
Isaev, V.N., Efficiency of crude oil desalting in horizontal electrodehydrators, 3:25777
Isakson, J.S., *See* Simenstad, C.A., 3:26927
Ishihama, W., Aftergases of coal dust explosions generated in an experimental chamber, 3:25676
Ishikawa, Y., Magnetic excitations in the weak itinerant ferromagnet MnSi, 3:26610
Ishimasa, Y., Development and operational experiences of LNG in-ground storage tanks in Japan. Parts I and II, 3:25886
Ishiyama, T., *See* Tada, B., 3:25885
Ishkhanov, G.S., *See* Melik-Akhnazarov, T.Kh., 3:25778
Isozaki, M., *See* Fukui, K., 3:25809
Ito, A., *See* Matsuzuru, H., 3:25942
Ito, H., *See* Hori, K., 3:26781
Ito, R., *See* Hirakawa, S., 3:25854
Ito, Y., *See* Fukui, K., 3:25809
Itoh, H., *See* Hori, K., 3:26196
See Ozaki, K., 3:26569
Itoh, K., *See* Euteneuer, H., 3:27343
Itoh, S., Newly developed UTR type marine reheat boiler, 3:26589
See Tominaga, H., 3:25899
Itoh, T., *See* Nakamura, Y., 3:27573
See Shibata, T., 3:27434
Iton, L.E., Trapping and stabilization of hydrogen atoms in intracrystalline voids. Defected calcium fluorides and Y zeolite surfaces, 3:26698
Ivandaev, A.I., Calculation of two-phase critical flow using the model of disperse: annular flow, 3:26771
Ivanov, A.G., *See* Aizen, Kh.K., 3:26165
Ivanov, A.L., *See* Gladkikh, V.A., 3:25816
Ivanov, N.V., *See* Buzankin, V.V., 3:27451
Ivanov, R.I., *See* Rusakov, M.M., 3:26613
Ivanov, R.S., Experimental study of an electrical discharge laser with supersonic gas flow in a magnetic field, 3:26744
Ivanov, V.A., *See* Pozdnyak, N.Z., 3:26623
Ivanova, N.I., *See* Alekhnovich, A.N., 3:25675
Ivanova, T.S., *See* Stekhun, A.I., 3:25820
Ivanyukov, D.V., *See* Gun, R.B., 3:25789
Iversen, S., Neutron deformation parameter from comparative study of π^+ and π^- inelastic scattering, 3:27335
Iwasaki, T., *See* Saito, M., 3:25783
Izmailov, T.Z., *See* Bernadiner, M.G., 3:25756
Izumi, N., *See* Ozaki, K., 3:26569

J

Jabsen, F.S., Cell-shaped fuel element spacer grid construction, 3:26399
Device for dismounting fuel elements, 3:26389
Nuclear reactor fuel element, 3:26395
Jackson, F., Material for shutting down gas cooled nuclear reactors, 3:26407
Jackson, H.E., Energetic charged particle yields induced by pions on complex nuclei, 3:27360 (ANL—77-60, pp 25-26)
Gamma rays from pion-induced reactions, 3:27359 (ANL—77-60, pp 24-25)
Study of pion-absorption mechanisms in ^{4}He and other nuclei, 3:27323
See Bowles, T., 3:27334
See Laszewski, R.M., 3:27331, 3:27376
Jacobs, R.R., *See* Krupke, W.F., 3:27680
Jacobs, S.M., *See* Briefel, E., 3:27140
Jacquinot, J., *See* Adam, J., 3:27428
Jacquot, C., *See* Geller, R., 3:27652
Jaeger, E.F., *See* Hedrick, C.L., 3:27605
Jaffe, A., Bound states, critical points, and recent results in quantum field models, 3:27302
Jaffe, R.L., Baryon excitations in the bag model, 3:27216 (SLAC-PUB—1774)

Jain, A.K., Problem of several delta-shell potentials in the Lippmann—Schwinger formulation, 3:27407
Jaklevic, J.M., Automated elemental analysis using energy dispersive x-ray fluorescence analysis, 3:26879 (LBL—7211)
Jakobson, M.J., *See* Fisher, T.R., 3:27375
Jakubowski, F.M., *See* Bliss, W.A., 3:26911
Jamba, D.M., Semiconductor measurement technology: some aspects of dose measurement for accurate ion implantation, 3:26825 (PB—269776)
James, L.W., GaAs solar cells for very high concentrations, 3:26000
James, T.C., Laboratory investigation of infrared fluorescence of CO_2, HAES report number 60. Final report 1 AGusut 1975—31 December 1976, 3:26853 (AD-A—043524)
Jameson, A., *See* Caughey, D.A., 3:27091
Jamieson, I.M., Heat flow in a geothermally active area: the Geysers, California, 3:26099
Janda, R.S., *See* Brueckner, K.A., 3:27459
Jankowski, D., *See* Barish, S.J., 3:27116
Jankus, V.Z., *See* Billone, M.C., 3:26318
Jansa, L.F., Geology of the Amoco Imp Skelly A-1 Osprey H-84 well, Grand Banks, Newfoundland, 3:25743
Jansen, G., *See* Friedrich, G., 3:26460
Janssen, D., *See* Jolos, R.V., 3:27389
Jarmie, N., Statistical analysis of ^{4}He(p,p)^{4}He data, 3:27325
See Haglund, R.F. Jr., 3:27324
Jaros, J.A., *See* Scharre, D.L., 3:27113
Jashnani, I.L., *See* LaMantia, C.R., 3:25678
Jasper, D.K., Structural variations of the endoplasmic reticulum of the jejunal mucosal cell, 3:26978 (CONF-770504—, pp 36-42)
Jassby, D.L., *See* Goldston, R.J., 3:27592
Jaudet, A., Dynamical behavior of industrial structures made of reinforced concrete, 3:26384
Jaworowski, Z., Population hazards associated with fossil fuel and nuclear power production, 3:26419
Jeffries, C.D., Strain-confined electron-hole liquid in germanium, 3:26646
Jena, P., Self-consistent screening of a positive muon in a spin-polarized electron gas, 3:26604
Systematics in the Knight shift of rare-earth monopnictides, 3:26600
Jenkins, D.J., *See* Book, D.L., 3:27600
Jenkins, J.F., *See* Black, S.A., 3:25958
Jenkins, T.M., *See* McCall, R.C., 3:26820, 3:26822
See Nelson, W.R., 3:26796
Jenkins, W.A.M., *See* Jansa, L.F., 3:25743
Jennison, D.R., Lithium local-orbital energy bands using Kohn-Sham and near- Hartree-Fock exchange, 3:26606
Jensen, D., *See* Anderson, M., 3:26814
Jensen, R.V., Calculations of impurity radiation and its effects on tokamak experiments, 3:27627
Jeppeson, R.H., *See* Fisher, T.R., 3:27375
Jevicki, A., *See* Halpern, M.B., 3:27274
Jewell, W.J., Anaerobic fermentation of agricultural residues: potential for improvement and implementation. Fourth quarter progress report, March 2, 1977—June 15, 1977, 3:26010 (COO/2991—19, pp 47-48)
Johnson, A., *See* Prettie, C., 3:27041
Johnson, A.C., Economic assessment of the utilization of lead-acid batteries in electric utility systems. Final report, 3:26522 (HCP/T2857—1)
Johnson, B.M., *See* Pegg, D.J., 3:27080
Johnson, B.V., *See* Roepke, W.W., 3:25700
Johnson, C.H., Anomalous optical-model potential for sub-Coulomb protons for $89 < A < 130$, 3:27361
Statistical model radiation widths for $75 < A < 130$ and the enhancement of p-wave neutron capture for $A \cong 90$, 3:27362
Johnson, C.R., Procedure for drying humidity-containing bodies, 3:26393
Johnson, D., *See* Bretz, N., 3:27472
See Chaney, D., 3:27121
Johnson, D.J., An investigation of 10 to the 12th power w per sq cm focused reb deposition of thick aluminum targets. Interim report, 3:27397 (AD-A—042211)
Johnson, D.P., *See* Guildner, L.A., 3:26116
Johnson, K.F., *See* Fisher, T.R., 3:27375
Johnson, L.C., *See* Schuss, J.J., 3:27440
Johnson, P.L., Ecosystem paradigm for ecology, 3:26893 (ORAU—129)
Johnson, P.W., Disentangling the scattering matrix when there is a dominant reaction mechanism, 3:27208
Johnson, W.B., *See* Gilchriese, M.G.D., 3:27138
Johnson, W.L., Plasma polymerization coating of D-T filled glass shells for laser fusion targets, 3:27682 (UCRL—80162)
Johnston, G.L., Integral representations of particular integrals of a class of inhomogeneous linear ordinary differential equations, 3:27416
Johnston, J.R., *See* Stephens, J.R., 3:26578
Johnston, T.W., *See* Grek, B., 3:27686
Jolos, R.V., Microscopic theory of nuclear quadrupole excitations, 3:27389
Joncas, K.P., Diagnostic motor vehicle inspection demonstration projects, program engineering support. Volume 7. Appendix f. Fuel economy evaluation. Final report November 1974—December 1976, 3:26587 (PB—270995)
Jonckheere, A.M., Study of final states in $\pi^- N \to \mu^+ \mu^- +$ hadrons at 225 GeV, 3:27144
Jones, D.C., *See* Murray, D.K., 3:25688
Jones, F.E., *See* Guildner, L.A., 3:26116
Jones, K.W., *See* Pegg, D.J., 3:27080
Jones, M.D., *See* Ballagh, H.C., 3:27114
Jones, R., Accelerated thermalization of an inhomogeneous beam-plasma system, 3:27514
Jones, R.W., *See* Driver, P.M., 3:26064
Jones, W.A., SHIVA Nd: glass disk-amplifier-assembly facility and special purpose fixtures, 3:27671 (UCID—17703)
Jones, W.D., *See* Kinney, R.J., 3:26676
Jordan, J.B., Ignition of droplets of liquid fuels solvent extracted from coal, 3:25718
Joseph, S.A., *See* Knigge, K.M., 3:26983
Joubert, F.E., *See* Barnes, V.C., 3:25724
Juergensen, H., Energy shortage and price increases: effects on world economy and standard of living, 3:26501

K

Kaast, H., Denitrogenation plant Clenze, 3:25832
Kadar, S., *See* Spencer, D.W., 3:26930
Kadirov, N.B., Problem of stability of drill pipe strings, 3:25755
Kadota, K., Lithium ion source of thermionic emission type, 3:27657 (IPPJ-DT—51)
Kadyrova, G.I., Use of a third-order Latin square in selecting hydrocracking catalysts, 3:25775
Kaelline, J., *See* McCarthy, J., 3:27318, 3:27319
Kaeppeler, H.J., Neutron production in the dense plasma focus, 3:27484
Kagan, D.N., *See* Shpil'rain, E.E., 3:26639
Kagan, Yu.B., *See* Rozovskii, A.Ya., 3:25967
Kagaya, Y., *See* Kasuya, K., 3:27530
Kahana, S.H., *See* Dover, C.B., 3:27228
Kahn, S., *See* Bogert, D., 3:27145
Kahn, S.A., *See* Cnops, A.M., 3:27106
Kaiser, G., *See* Hanna, I., 3:26410
Kakehi, K., *See* Ueda, K., 3:25884
Kalafati, D.D., Comparison of heat transfer efficiency of gases flowing in smooth and rough channels, 3:26177
Mathematical model of a direct-flow boiler with stream heating, 3:26162
Kalechits, I.V., Main developmental tendencies in the high-volume, organic synthesis industry, 3:25790
Kaliberdo, L.M., Complete catalytic oxidation of vapor mixtures containing phenol and hydrogen sulfide, 3:26678
Kalinevich, G.E., *See* Angelopulo, O.K., 3:25757
Kalmykov, A.N., *See* Romanov, V.A., 3:26160
Kamanin, V.V., *See* Bugrov, V.N., 3:27382
Kameari, A., Eddy currents induced on the torus with non-uniform resistances, 3:27635 (JAERI-M—6953)
Kaminskii, E.F., *See* Gun, R.B., 3:25789
Kamishita, M., Effect of carbon deposition on porosity and reactivity of a lignite char, 3:25666
Kammash, T., Theoretical investigations relevant to magnetic fusion energy research. Progress report, January 1, 1977—January 1, 1978, 3:27537 (CONF-771136—25)
See Rizk, H.M., 3:27515
Kammerer, O.F., *See* Wiesmann, H., 3:26602
Kanazawa, H., *See* Ueda, K., 3:25884
Kane, J.R., *See* Roberson, P., 3:27130
Kang, H.K., *See* Cisneros, E.L, 3:26831
Kang, K., *See* Feldman, D., 3:27146
Kanoh, J., *See* Murata, Y., 3:25868
Kantelo, M.V., *See* Nethaway, D.R., 3:27381
Kapany, N.S., Solar collectors using total internal reflections, 3:26078
Kaper, H.G., *See* Hangelbroek, R.J., 3:27713
Kaplan, M., *See* Miller, J.M., 3:27379
Kaplan, S.I., *See* Anderson, T.D., 3:26032
Kapp, K.W., Governmental promotion of technologies not harmful to the environment, 3:26518
Karachinskii, V.F., *See* Goncharov, V.V., 3:26428
Karaibog, M.V., *See* Gundyrev, A.A., 3:25779
Karamyan, S.A., *See* Bugrov, V.N., 3:27382
Karapetyan, R.V., Negative absorption in an anisotropic plasma, 3:27589
Karibdzhanyan, N.A., *See* Swmylina, I.A., 3:25970
Karliner, I., *See* Chang, S., 3:27152
Karlsson, B.R., New equations for four-body scattering, 3:27310
Karpenko, N.N., *See* Kaliberdo, L.M., 3:26678
Karpman, V.I., Two-dimensional self-modulation of a whistler wave propagating along the magnetic field in a plasma, 3:27580
Karpov, V.G., Economico-mathematical formulation of the problem of optimization of the construction of the linear part of oil pipelines, 3:25811
Karpukhin, V.T., *See* Ivanov, R.S., 3:26744
Karsten, G., SNR-carbide program: its position between present and future, 3:26295
Karvonen, L.G., *See* Allen, M.A., 3:26812
Kasai, M., Poloidal distributions of radiation heating and 14 MeV neutron flux at first wall, 3:27697 (EUR—5602, pp 657-663)
Kasai, S., *See* Nakamura, Y., 3:27505

Kasimova, Sh.S., Determination of leakage of a liquid obeying an exponential model, in the piston-cylinder gap of a deep pump, 3:25759
Kassner, D.A., *See* Brown, D.P., 3:26808
Kastenberg, W.E., Risk assessment in the absence of complete data, 3:26453
Kasuya, K., Crowbar experiments by ionizing shock waves and new methods, 3:27530 (EUR—5602, pp 311-316)
Kato, D., Ultra low-temperature LNG compressors, 3:25889
Katok, V.L., *See* Kerimov, T.G., 3:25829
Katsoufis, E., *See* Briefel, E., 3:27140
Katsura, T., *See* Ballagh, H.C., 3:27114
Katsurai, M., *See* Saito, H., 3:27457, 3:27462
See Sato, K.N., 3:27427
Katsuyama, K., *See* Motojima, K., 3:25931
Katz, J.J., *See* Scheer, H., 3:26674
Kauffmann, S.K., *See* Baltz, A.J., 3:27369
Kaufman, A.N., *See* Cohen, B.I., 3:27569
Kaufman, P.C., *See* Saunders, B.B., 3:26695
Kaufman, S.B., *See* Jackson, H.E., 3:27360
Kaufmann, M., High beta stellarator, a toroidal confinement system, 3:27607
Kawabe, T., *See* Kawamura, T., 3:27431
Kawakami, H., *See* Cole, J.D., 3:27370
See Ronningen, R.M., 3:27374
Kawamura, T., Roles of turbulence on plasma heating, 3:27431 (IPPJ—255)
Kawasumi, Y., *See* Kadota, K., 3:27657
Kayser, B., *See* Fischbach, E., 3:27200
Kazakova, L.P., *See* Gundyrev, A.A., 3:25779
Kazama, Y., Electric and magnetic dipole moments of the bound system of a Dirac particle and a fixed magnetic monopole, 3:27270
See Hagiwara, T., 3:27148
Kazaryan, G.K., *See* Abramyan, L.O., 3:27105
Kazuno, M., *See* Whitmore, J., 3:27139
Kearns, D.L., Advanced coal gasification system for electric power generation. Sixty-third monthly progress report, October 1977, 3:25628 (FE—1514-73)
Keer, L.M., *See* Weertman, J., 3:26106
Kehler, P., *See* Forster, G.A., 3:26278
Keirstead, R.C., *See* Hickok, W.W., 3:26130
Keister, P.L., Recovery and purification of uranium-234 from aged plutonium-238, 3:26666 (MLM—2490)
Keith, A.D., Spin label studies on membranes and the aqueous zones of membrane enclosures. Progress report, period covered: August 1976 to the present, 3:26959 (COO—2223-25)
Kellogg, H.E., Geology and petroleum of the Mancos B formation, Douglas Creek arch area, Colorado and Utah, 3:25738
Kelly, H., *See* Bruzzone, H., 3:27493
See Vargas, M., 3:27485
Kelp, F., *See* Tratz, H., 3:26224
Kenah, L., *See* Mollet, W., 3:27123
Kenda, S., *See* Bush, T.W., 3:25619
Kennedy, J.E., Shock-wave evolution in chemically reacting solid, 3:26848
See Nunziato, J.W., 3:26847
Kennedy, T.C., Laboratory investigation of rock cavity reinforcement. Final report, 17 September 1974—16 March 1976, 3:26851 (AD-A—043398)
Kenney, V.P., *See* Biswas, N.N., 3:27132
Keoemley, G., *See* Bereznai, T., 3:26249
Kerber, R.L., Simple model of a chain-reaction pulsed HF laser. Interim report, 3:26728 (AD-A—043319)
Kerbikov, B.O., *See* Dal'karov, O.D., 3:27236
Keren, J., *See* Chaney, D., 3:27121
Kerimov, T.G., Estimation of carbonate reservoirs of East Turkmeniya from the lateral-logging and neutron-gamma logging data, 3:25829
Kernan, A., Colliding pomerons-experimental situation and outlook, 3:27120 (TID—28065)
Quark—quark interactions at the p anti p Collider, 3:27207 (TID—28062)
Kernan, W.J., *See* Whitmore, J., 3:27139
Kernell, R.L., *See* Johnson, C.H., 3:27361
Kerrisk, J.F., Design and performance of shroud tubes, 3:26325
Kershaw, D.S., Incomplete cholesky - conjugate gradient method for the iterative solution of systems of linear equations, 3:27712
Kesten, A.S., *See* Sangiovanni, J.J., 3:26702
Ketchen, M.B., Temperature fluctuations in freely suspended tin films at the superconducting transition, 3:26601
See Gamble, T.D., 3:26711
Key, A.W., *See* Goddard, M.C., 3:27141
Keyes, G., *See* Lys, J.E.A., 3:27126
Khajretdinov, R.Sh., *See* Tsvetov, V.V., 3:25763
Khan, E.U., *See* Mikic, B., 3:26280
Khapov, Yu.I., Chemical hf laser operating at high pressure of the active medium, 3:26769
Khavkin, V.A., *See* Radchenko, E.D., 3:25771
Khenat, B., First years of operation of the Skikda LNG plant with a discussion of mercury chemical corrosion of aluminum cryogenic exchangers, 3:25837
Khokhlov, L.K., *See* Levental', G.B., 3:26534
Khora, Kh., Increa e of thermonuclear field on fast implosion of cold shell targets by means on nonlinear interaction of laser radiation with plasma, 3:27691
Khoshev, I.M., Operation of a traveling-wave laser with periodically varying cavity parameters. Fast rotation, 3:26762
Khoshmukhamedov, R.A., *See* Bannik, B.P., 3:27118
Khoury, B.V., *See* Briefel, E., 3:27140
Khriley, L.S., *See* Savin, V.I., 3:26545
Khudoveryan, A.G., *See* Abramyan, L.O., 3:27105
Khurshudyan, L.S., *See* Abramyan, L.O., 3:27105
Khutoryanskii, F.I., *See* Isaev, V.N., 3:25777
Kidnay, A.J., Enthalpy measurement of coal-derived liquids. Quarterly technical progress report, October—December 1977, 3:25652 (FE—2035-10)
Kiehl, J.T., *See* Lichtenberg, D.B., 3:27185
Kijima, K., *See* Teo, B.K., 3:26675
Kikuchi, E., *See* Kimura, T., 3:25785
Killeen, J., *See* Dibiase, J.A., 3:27560
Kilroy, W.P., Measurement of battery separator resistances in low impedance conductivity cells by ac bridge techniques. Progress report, 3:26488 (AD-A—042182)
Kim, H.J., *See* Robinson, R.L., 3:27358
See Wells, J.C. Jr., 3:27357
Kim, J.E., Conditions for natural suppression of CP violation, 3:27251
Kim, K., *See* Foster, C.A., 3:27664
Kimber, G.M., *See* Jordan, J.B., 3:25718
Kimura, H., Diagnostics of a scrape-off layer plasma, 3:27613 (JAERI-M—6971)
Electrostatic diagnostics of JFT-2a (DIVA), 3:27467 (JAERI-M—6861)
Kimura, T., Steam reforming of hydrocarbons on alkali polyaluminate catalysts. II. Reactivity of deposited carbon, 3:25785
Kinemond, G.A., *See* Chapman, L.D., 3:25954
King, J.M. Jr., Advanced technology fuel cell program. Interim report, 3:26543 (EPRI-EM—576)
King, T., *See* Roberson, P., 3:27130
King, W.C., Hazard analysis of uranium inhalation at the Lawrence Livermore Laboratory, 3:26998 (UCID—17673)
Kinnear, J., *See* Romney, E.M., 3:26913
Kinney, J.D., *See* Barr, W.L., 3:27666
Kinney, R.J., Synthesis and characterization of [(eta^5-C_5H_5)V(CO)$_3$H]$^-$, a new anionic vanadium carbonyl hydride, and a study of its reduction reaction with organic halides. Observation of a free-radical chain process having an extremely rapid metal-to-carbon hydrogen transfer step, 3:26676
Kinoshita, K., *See* Ackerman, J.P., 3:26542
Kintner, E.E., Survey of the U.S. magnetic fusion program, 3:27594 (EUR—5602, pp 225-244)
Kir'yenin, I.A., *See* Zenkevich, V.B., 3:26539
Kircher, J.F., *See* Barnes, R.H., 3:26700
Kirillov, A.P., *See* Minsker, K.S., 3:25776
Kirk, W.L., Cryogenics program, 3:26709 (LA—6807-PR, pp 2-33)
Energy technology. Progress report, January—March 1977, 3:26504 (LA—6807-PR)
Fission reactor critical experiments and analysis, 3:26345 (LA—6807-PR, pp 72-79)
Reactor and advanced heat transfer technology, 3:26705 (LA—6807-PR, pp 60-71)
Kirkonos, V.A., Controlling the filling of alkaline batteries, 3:26492
Kirkwood, J.B., *See* Fuller, R.G., 3:26907
Kirov, A.G., *See* Demirkhanov, R.A., 3:27452
Kirsch, L., *See* Briefel, E., 3:27140
Kiskis, J., U(1) gauge theories, fiber bundles, and stereographic projections in two dimensions, 3:27277
Kissell, F.N., *See* Matta, J.E., 3:25706, 3:25893
See Vinson, R.P., 3:25691
Kitamura, M., *See* Tada, B., 3:25885
Kiteley, L.W., Shallow marine deposits in the Upper Cretaceous Pierre Shale of the northern Denver basin and their relation to hydrocarbon accumulation, 3:25739
Kito, M., *See* Takeda, S., 3:27595
Kittel, J.H., *See* Simmons, J.M., 3:26293
Kittle, H., *See* Leary, J., 3:26292
Kiyama, H., *See* Takeda, S., 3:27595
Kiyama, S., *See* Takeda, S., 3:27595
Kland, M.J., Priori predictive methods of assessing health effects of chemicals in the environment, 3:26878 (LBL—6372)
Klapisch, M., *See* Schwob, J.L., 3:27490
Klauder, J.R., Value and the scope of quantum field theory, 3:27299
Kleb, R., *See* Maglic, R.C., 3:26605
Kleimenov, N.G., Chemical purging of K-300-240 turbines made at Kharkov Turbogenerator Works during overhauls, 3:26174
Klein, H., Device for welding pipes onto pressurized elements, like tube sheets, pressure vessels, headers and the like, 3:26380
Kleinstein, B.H., Biological effects of nonionizing electromagnetic radiation. Volume II, Number 1. A digest of current literature. Quarterly report June—September 1977, 3:27000 (AD-A—043458)
Klement'ev, V.M., *See* Dolgopolov, S.G., 3:26755
Klemm, R.B., Rate parameters for the reactions of formaldehyde with H-atoms and O-atoms over the temperature range 250 to 470 K, 3:26670 (BNL—23550)
Klems, J.H., *See* Jonckheere, A.M., 3:27144

Klett, J.D., Use of boundary layer theory to determine the internal circulation of falling drops, 3:27092
Kleykamp, H., Chemical state of irradiated carbide fuel pins, 3:26641
Klimenko, T.M., *See* Maslyanskii, G.N., 3:25772
Kline, R.V., *See* Bebek, C.J., 3:27104
Klinetob, R.H., *See* Caspersson, S.A., 3:26323
Klippel, H., *See* Klein, H., 3:26380
Kloet, W.M., Dynamics of N-N total cross sections at medium energies, 3:27227
Klopfer, H., Transport of liquids and gases through coatings, 3:26689
Kluge, H., Method and equipment for the continuous determination of the content of burnable components in powder form bulk goods, 3:26663
Klump, K.N., Energy transfer cross sections in relation to generalized oscillator strengths for the donor—acceptor pair benzene—acetone, 3:27065
Klunder, K., *See* Landgrebe, A.R., 3:26485
Knapp, R., *See* Norton, D., 3:26083
Knell, E.W., Flash pyrolysis coal liquefaction process development. Monthly report, July 1977, 3:25654 (FE—2244-15)
Knigge, K.M., Challenge of pineal gland structure and function, 3:26983 (CONF-770504—, pp 72-87)
Knight, J., Operation of instruments in adverse environments, 1976, 3:26816
See Norton, D., 3:26084
Knight, R.G., *See* Duvel, W.A. Jr., 3:25680
Kniseley, R.N., *See* Winge, R.K., 3:26664
Knutson, L.D., *See* Fisher, T.R., 3:27375
Knyazevskaya, G.S., *See* Tuchin, V.V., 3:26746
Ko, W., *See* Jonckheere, A.M., 3:27144
Kobayashi, M., Utilization and disposal of wastes by photosynthetic bacteria, 3:26003
Kobayashi, N., *See* Kadota, K., 3:27657
Kobayashi, T., Effect of plasma minor-radius expansion in the current build-up phase of a large tokamak, 3:27615 (JAERI-M—7014)
Kobeliev, B.M., *See* Gestryina, G.M., 3:27581
Kobzarov, N.Y., Mesons from gluons, 3:27219
Kocher, D.C., Standardized radioactive decay data sets for use in radiation dosimetry, 3:26991 (IAEA-SM—222/51)
Kochina, I.N., Percolation through clay crusts, 3:25762
Kodama, K., *See* Ozaki, K., 3:26569
Koenig, H.H., Politics and engineering in nuclear-energy installations, 3:26465
Koeppendoerfer, W., Limits in the production of a low compressed high-beta plasma in the linear theta pinch Isar II, 3:27535
Koevesi-Domokos, S., *See* Domokos, G., 3:27246
Kogan, S.B., *See* Bursian, N.R., 3:25793
Kogan, Yu.S., *See* Melik-Akhnazarov, T.Kh., 3:25778
Kogoshi, S., *See* Sato, K.N., 3:27427
Kohgi, M., *See* Ishikawa, Y., 3:26610
Kohlberg, C.N., *See* Roe, J.M., 3:26834
Kolarz, C.R., *See* Duvel, W.A. Jr., 3:25680
Kolata, J.J., *See* Warburton, E.K., 3:27346
Koldewitz, W., Testing tar-epoxide-coating materials under practice-like conditions in the laboratory, 3:26703
Kolesnichenko, Ya.I., Thermal thermonuclear instability in a tokamak reactor, 3:27550
Kollie, T.G., Measurement of the thermal expansion coefficient of nickel from 300 to 1000 K and determination of the power-law constants near the Curie temperature, 3:26609
Kollmar, W., Nuclear power plant with a heat exchanger serving as steam generator, 3:26480
Kologrivov, A.A., *See* Basov, N.G., 3:27689
Kolokolov, N.E., *See* Maklakova, V.P., 3:26158
Koltai, P., *See* Ambrus, Gy., 3:26373
Koltun, D.S., *See* Mizutani, T., 3:27317
Kolykhan, L.I., *See* Zdanovich, N.N., 3:26383
Komatsu, J., *See* Uematsu, K. Ishida, Y., 3:26301
Komm, D.S., *See* Hutchinson, I.H., 3:27497
Kondo, S., *See* Kasai, M., 3:27697
Kondrashov, V.E., *See* Elesin, V.F., 3:27405
Konieczko, A., Some characteristics of the first Polish atomic power station relating to its effect on the environment, 3:26418
Konya, M.J., Hybrid computer simulation of the LOFT plant, 3:26228 (LTR—10-2B)
Koof, A.P., Nuclear power is not only necessary, but it can also be mastered. EGM talk with Guido Brunner, 3:26450
Koontz, R.F., Fast pulse beam generation systems for electron accelerators, 3:26797 (SLAC-PUB—1948)
Kopysov, Y.S., *See* Andreev, Y.M., 3:27233
Kornblum, H.N., *See* Haas, R.A., 3:27448
Korolev, N.M., *See* Ivanov, R.S., 3:26744
Koroteev, A.S., High-power electric-arc generators of low-temperature plasma, 3:27534
Korotov, E.I., *See* Burgvits, G.A., 3:26140
Korshunov, I.G., Thermophysical properties of cubic carbides of zirconium and niobium at high temperatures, 3:26615
Korsun, A.S., Calculation of the temperature field in a fuel element with a rod core and a peeling sheath, 3:26404
Korzhavin, V.M., *See* Vikhrev, V.V., 3:27517
Korzhov, E.N., *See* Kleimenov, N.G., 3:26174
Kostenko, A.I., *See* Egorov, S.A., 3:27651
See Glukhikh, V.A., 3:27645, 3:27650
Kotsinyan, A.M., *See* Dul'yan, L.S., 3:27063
Kovalenko, V.K., *See* Tsybulevskii, A.M., 3:25773
Kovalev, G.I., Mechanism of action on rubber by products from thermal oxidation of hydrotreated fuels, 3:25787
Kovalevskii, V.I., *See* Dolgopolov, S.G., 3:26755
Kovan, D., Safety no obstacle to a British PWR, 3:26458
Kovan, I.A., *See* Buzankin, V.V., 3:27451
Kovar, D.G., Energy dependence of $^{32}S + ^{24}Mg$ fusion cross sections, 3:27341 (ANL—77-60, pp 41-43)
Energy dependence of the distribution of reaction strength in the $^{16}O + ^{40}Ca$ collisions, 3:27351 (ANL—77-60, pp 45-48)
See Geesaman, D.F., 3:27350
See Rehm, K.E., 3:27352
See Tabor, S.L., 3:27340
Kovbasyuk, V.I., *See* Bityurin, V.A., 3:26537
Kowalczyk, S.P., *See* Ley, L., 3:26608
Kowalski, S., *See* Euteneuer, H., 3:27343
Kozlovskii, D.A., *See* Aristov, A.V., 3:26748
Kozlowski, B., Investigation of effects of concussion blasting combined with drilling destressing boreholes in roadsides, on the reduction of gas and rock bursts hazards, 3:25699
Kraemer, R.W., *See* Lys, J.E.A., 3:27126
Kraetzig, W.B., Supporting behaviour of natural-draft cooling towers under special consideration of mining influences, 3:26139
Krafczyk, G., *See* Barish, B.C., 3:27115
Krainov, V.N., Economic efficiency of optimizing existing units for carbon monoxide conversion, 3:25971
Krakowski, R.A., Pure-fusion and fusion-fission reactor applications of high-density linear confinement systems, 3:27454
See Bartsch, R.R., 3:27540
Krall, N.A., *See* Davidson, R.C., 3:27556
See Hedrick, C.L., 3:27605
Kramer, J.M., *See* Billone, M.C., 3:26318
Kramer, N.A., *See* Holtz, R.E., 3:26432
Kramer, P.E., Marco image converter camera. Period covered: July—September 1977, 3:26838 (MHSMP—77-50)
Krane, K., *See* Swenson, L.W., 3:27342
Kraus, W., *See* Gaertner, K., 3:26230
Kraushaar, J.J., *See* Zimmerman, W.R., 3:27349
Kress, T.S., *See* Fontana, M.H., 3:26439
Kressel, H., Recent advances in heterojunction lasers, 3:26768
Kroh, G.C., *See* Dux, C.D., 3:25720
Krohm, G.C., National coal utilization assessment: the price and availability of low sulfur coal in eastern markets, 3:25719 (ANL/AA—12)
Krokhin, O.N., Summary of inertial confinement, 3:27685
See Afanas'ev, Yu.V., 3:27690
See Basov, N.G., 3:27688, 3:27689
Kroopnick, P.M., Geochemistry of the Hawaii geothermal well, HGP-A (abstract), 3:26100
Kruer, W.L., *See* Estabrook, K., 3:27444
See Haas, R.A., 3:27448
See Phillion, D.W., 3:27447
Krug, H., Impulse cytophotometric investigations on melanoblastoma, 3:26965 (LA-tr—78-2)
Mathematical model of the connection between the DNA karyogram and the cell cycle. Part 1. Derivation of the DNA frequency distribution from the duration of the individual phases of the cell cycle, 3:26964 (LA-tr—78-3)
See Taubert, G., 3:26966
Kruk, M.T., *See* Mysak, I.S., 3:26154
Krupenikov, V.V., Technology of acoustic pipe cleaning at power engineering plants, 3:26182
Krupin, V.A., *See* Buzankin, V.V., 3:27451
Krupke, W.F., Advanced lasers for power production, 3:27678 (UCRL—52000-77-8, pp 30-37)
Rare earth vapor laser studies, 3:27680 (UCRL—79364)
Kruse, T.H., *See* Pegg, D.J., 3:27080
Krutiev, V.A., Influence of exhaust gas recirculation on the formation of nitrogen oxides during the burning of oil, 3:26195
Kryazhev, Yu.G., *See* Filimonova, T.A., 3:25821
Krylov, Y.N., *See* Bursak, A.V., 3:27387
Kubasov, V.A., *See* Burtsev, V.A., 3:27460
Kubota, H., *See* Kimura, T., 3:25785
Kucherov, M.N., *See* Krainov, V.N., 3:25971
Kudrova, L.G., *See* Korsun, A.S., 3:26404
Kuhl, D.E., *See* Phelps, M.E., 3:26993
Kuhl, E., *See* Klein, H., 3:26380
Kukushkin, A.N., *See* Deich, M.E., 3:26772
Kul'mukhametov, T.Ya., *See* Polynovskii, Ya.L., 3:26159
Kulcinski, G.L., *See* Avci, H.I., 3:27618, 3:27619, 3:27620
See Conn, R.W., 3:27601
Kulikov, V.E., *See* Borisov, G.M., 3:26170
Kuloyan, L.T., *See* Marukhyan, V.Z., 3:26138
Kulwich, M.R., *See* Caspersson, S.A., 3:26323
Kumin, H., *See* Day, H.W., 3:26118
Kummerer, K.R., German carbide irradiation test experience for fast reactors, 3:26308

Kunisada, N., *See* Fukui, K., 3:25809
Kunselman, R., *See* Roberson, P., 3:27130
Kunz, P.F., *See* Gilchriese, M.G.D., 3:27138
Kuppermann, A., Technical progress report, 1 July 1976—30 November 1977, 3:27064 (CALT—767P4-161)
Kupsch, J., Conformal invariance of quantum fields in two-dimensional space—time, 3:27304
Kuramochi, Y., *See* Ueda, K., 3:25884
Kuranova, V.I., *See* Kovalev, G.I., 3:25787
Kurihara, M., *See* Watanabe, H., 3:26311
Kurnaev, V.A., Resolution of thin foils applicable in corpuscular plasma diagnostic, 3:27479
Kuroda, P.K., Analysis of possibility of reactors occurring in nature, 3:26350
Kuroda, Y., Identification of a nuclear reactor system by means of gradient methods, 3:26351
Kuroiwa, F., *See* Matsuda, S., 3:25822
Kursh, S.J., Installation and maintenance of solar heating systems, 3:26053
Kurtz, R.J., Fracture mechanics of thin wall cylindrical pressure vessels: an interim review, 3:26442 (PNL—2417)
Kurtz, S.R., Approximate method for determining the influence of water and porosity on the Gruneisen gamma, 3:26647 (UCRL—76010)
Kusano, S., *See* Hirakawa, S., 3:25850
Kuswa, G.W., *See* Chang, J., 3:27670
Kutsaeva, L.S., *See* Piksaikin, V.M., 3:27383
Kuzevanov, V.S., *See* Rassokhin, N.G., 3:26773
Kuznetsova, E.M., *See* Krupenikov, V.V., 3:26182
Kuznetsova, T.N., *See* Bityurin, V.A., 3:26537
Kwan, B.P., *See* Scharre, D.L., 3:27113

L

Laabs, F.C., Proceedings of the 14th annual electron microscopy colloquium, 3:26952 (CONF-770504—)
Three-hour rapid processing technique for electron microscopy, 3:26957 (CONF-770504—, pp 172-175)
Laburdova, E.V., *See* Egiazarov, Yu.G., 3:25815
Lachinov, S.S., *See* Swmylina, I.A., 3:25970
Lackner, K., *See* Becker, G., 3:27519
Lafery, H., *See* Bosholm, J., 3:26231
Lahr, H.W.H., Properties and irradiation behavior of advanced oxide particle fuel, 3:26305
Lai, K.W., *See* Goddard, M.C., 3:27141
Laidler, J.J., Status of international fuel cladding development, 3:26326
Laird, R.A., SPTF Flow Loop 18 inch butterfly valve cavitation test report, SPTF-LPP, 3:26284 (TID—28094)
Lam, C., *See* Sluyters, T., 3:26799
Lam, D.J., *See* Jena, P., 3:26600
Lam, P.C., *See* McCormack, R.G., 3:26660
Lam, S.K., *See* Barthold, W.P., 3:26322
Lam, W.C., *See* Roberson, P., 3:27130
LaMantia, C.R., Application of scrubbing systems to low sulfur/alkaline ash coals. Final report, 3:25678 (EPRI-FP—595)
Lamb, R.C., *See* Leeper, R.J., 3:27143
Lambert, D.G., Explosion yield verification, multiple explosion scenarios and three-dimensional seismic modeling research. Quarterly technical report, 1 May—31 July 1976, 3:26863 (AD-A—043386)
Simulation and decomposition of multiple explosions. Topical report, 3:26865 (AD-A—043390)
See Barker, T.G., 3:26864
Lamsa, J.W., *See* Biswas, N.N., 3:27132
Lance, E.D., *See* Hurt, S.S. III, 3:26423
Lanchi, M., *See* Calza-Bini, A., 3:26302
Landa, Y.A., *See* Litovskii, E.Y., 3:26642
Lander, G.H., *See* Maglic, R.C., 3:26605
Lander, R.L., *See* Jonckheere, A.M., 3:27144
Landgrebe, A.R., Federal battery program for transportation uses, 3:26485 (CONF-7606127—1)
Lane, R.O., Ohio University tandem Van de Graaff accelerator. Final report, 3:26788 (COO—1717-9)
Lanford, W.A., Hydrogen surface contamination and the storage of ultracold neutrons, 3:27315
Lange, C.S., Biological effects of ionizing radiation at the molecular, cellular, and organismal levels. Triannual progress report, July 15, 1974—October 14, 1977, 3:26984 (TID—28055)
Lange, J., *See* Collins, W.E., 3:27371
See Ronningen, R.M., 3:27373
Lange, R., PATRIC: a three dimensional particle-in-cell sequential puff code for modeling the transport and diffusion of atmospheric pollutants, 3:26884 (UCID—17701)
Lange, W.J., *See* Yang, T.F., 3:27621
Langhoff, P.W., *See* Rescigno, T.N., 3:27084
Lannutti, J.E., *See* Bogert, D., 3:27145
Lanou, R.E., *See* Humphrey, J.W., 3:26806
Lantratova, N.Y., *See* Shpak, V.S., 3:26361
Lantz, L.L., Design report and safety evaluation for high density fuel storage system. Licensing topical report, 3:26208 (NEDO—24076)
Lapikas, L., *See* Euteneuer, H., 3:27343
Lapshin, V.I., To the theory of heating of collisional plasma by means of magnetic pumping by axial-asymmetric variable fields, 3:27465
Lapthorn, J.C., *See* Buchlin, J.M., 3:26257
Larionov, V.V., Use of neutron—gamma logging data normalized from readings in a reference borehole to estimate the volume water content of carbonate rocks, 3:27019 (UCRL-Trans—11309)
Larsen, R.S., *See* Cisneros, E.L, 3:26831
Larson, C.E., *See* Roe, J.M., 3:26834
Larson, D., *See* Bebek, C.J., 3:27104
Laryushkin, M.A., *See* Dvoinnishnikov, V.A., 3:26535
LaScola, J.C., *See* Matta, J.E., 3:25706, 3:25893
Lasinski, T.A., *See* Gilchriese, M.G.D., 3:27138
Lass, J.L., Fuel rod bundles for nuclear reactors, 3:26403
Lassettre, E.N., *See* Klump, K.N., 3:27065
Lassila, K.E., *See* Chang, V., 3:27229
See Pietilaeinen, E.P., 3:27223
Laszewski, R.M., Direct and resonance photoneutron reactions of ^{17}O, 3:27331 (ANL—77-60, pp 108-109)
Distribution of M1 strength in ^{208}Pb, 3:27376 (ANL—77-60, pp 111-113)
See Bowles, T., 3:27334
Lathrop, K.A., *See* Genant, H.K., 3:26972
Latyev, L.N., *See* Shestakov, E.N., 3:26619
Lau, L.S., *See* Kroopnick, P.M., 3:26100
Laughlin, A.W., *See* Brookins, D.G., 3:26103
Laughlin, J.S., Biomedical research and application utilizing cyclotron produced radionuclides. Progress report, January 1 1977—December 31, 1977, 3:26971 (COO/4268—1)
Laurich, K., *See* Hildebrandt, E., 3:26385
Lautrup, B., Aspects of QED, 3:27293
Lawson, M.O., Electrofluid dynamic generators and cycle performances for optimally matched injectors. Final technical report Sep 74—Jul 76, 3:26540 (AD-A—046120)
Le Gardeur, R., Sources for high frequency heating. Performance and limitations, 3:27653 (CEA-CONF—3865)
Leaderer, B., *See* Tanner, R.L., 3:26872
Leaf, G.K., *See* Hangelbroek, R.J., 3:27713
Leary, D.F., *See* Davis, D.E., 3:25921
Leary, J., Advanced LMFBR fuels, 3:26292
Leary, J.A., *See* Simmons, J.M., 3:26293
Leary, K.M., Laser synthetic chemistry, 3:26692 (LA-UR—77-2790)
Lebedev, A.N., *See* Abramyan, L.O., 3:27105
Lebednik, P.A., Ecology of marine algae, 3:26925 (TID—26712, pp 353-393)
Leboeuf, J.N., *See* Grek, B., 3:27686
Leclercq-Willain, C., *See* Dietrich, K., 3:27392
Lecomte, P., *See* Scharre, D.L., 3:27113
Ledbetter, G.P., Bibliography of published material related to the Soviet PNE Program, 3:26856 (UCRL—52362)
Lee, A.Y., *See* Yang, T.F., 3:27621
Lee, D.O., Focused solar collector analysis with axially varying input due to shadowing from adjacent collectors, 3:26068
Lee, E.T.P., *See* O'Neil, R.R., 3:27035
Lee, K.C., Panel bed filter. Final report, 3:25677 (EPRI-AF—560)
Lee, Y.C., *See* Aamodt, R.E., 3:27548
Lee, Y.T., *See* Grant, E.R., 3:27047
See Sudbo, A.S., 3:27046
Leeper, R.J., Study of the reactions $\pi^- p \rightarrow \pi^+ \pi^- n$ and $\pi^- p \rightarrow K^+ K^- n$ at 1.98 and 2.41 GeV/c, 3:27143
Legler, H., *See* Schaude, G.R., 3:26555
Lehnert, B., Basic features of EXTRAP concept, 3:27598 (TRITA-PFU—77-01)
Power loss problems in EXTRAP coil systems, 3:27639 (TRITA-PFU—77-02)
Leibowitz, L., *See* Finn, P.A., 3:26633
Leites, I.L., *See* Dudakov, L.P., 3:25969
Leith, D.W.G.S., Progress in K spectroscopy, 3:27217 (SLAC-PUB—1980)
See Gilchriese, M.G.D., 3:27138
LeMaire, J.L., *See* Mobley, R.M., 3:26795
Lemberger, R.F., *See* Zuclich, J.A., 3:26999
Lembke, J.R., Digital analysis of EBW burst wave forms. Final report, 3:26845 (BDX—613-1668(Rev.))
Lenz, G., *See* Heller, H., 3:25786
Leone, S.R., Fundamental kinetic rate processes occurring in polyatomic vibrational lasers. Final technical report 11 Nov 76—11 Jun 77, 3:26733 (AD-A—046014)
Leont'ev, A.I., *See* Styrikovich, M.A., 3:26707
LePera, M.E., *See* Stavinoha, L.L., 3:25812
Leppin, D., Operating experience with the IGT cold-gas recycle methanation process in the HYGAS pilot plant, 3:25623 (CONF-771092—9)
Lesnik, A., *See* Ward, C.E.W., 3:27142
Lesnyakov, G.G., Effect of vacuum conditions on plasma production and confinement, 3:27698 (EUR—5602, pp 483-491)
Lesokhin, I.G., *See* Mukhlenov, I.P., 3:26668
Letts, S.A., *See* Johnson, W.L., 3:27682
Levchenko, A.S., *See* Zabortseva, T.A., 3:26751
Levchenko, G.I., *See* Shul'man, I.E., 3:26183
Levchenko, I.S., *See* Golovashkin, A.I., 3:26626
Levental', G.B., Complex study on a base-load MHD power station of open cycle, 3:26534
Levin, E.M., Simple interpretation of the Reggeon cutting rules, 3:27210
Levin, M.B., *See* Aristov, A.V., 3:26748

Levine, M.D., Interactions among the National Energy Plan and the President's Environmental Message: the Coal Conversion Regulatory Program, 3:26516 (TID—28130)
LeVine, M.J., *See* Kovar, D.G., 3:27341
Levinson, A.A., Hydrogen - a reducing agent in some uranium deposits, 3:25904
Levit, G.T., Ways to improve the technical level of operation of Ekibastuz coal-fired boilers, 3:26169
Levman, G., *See* Biswas, N.N., 3:27132
Levy, E.K., Centrifugal fluidized combustion of coal. Annual report for period ending September 1977, 3:25713 (FE—2516-4)
Levy, M., Weak and electromagnetic interactions at high energies. Part A, 3:27292
Lewand, S.J., Project financing of LNG trade, 3:25855
Lewis, E.C., Study of plant metallurgical requirements for low-Btu gasification of coal for electric power generation, 3:25629 (FE—1545-39)
Lewis, H.E., Solvent refined coal (SRC) process operation of solvent refined coal pilot plant at Wilsonville, Alabama. Annual report, January—December 1976, 3:25648 (EPRI-AF—585)
Ley, L., X-ray photoemission spectra of the valence bands of the 3d transition metals, Sc to Fe, 3:26608
Leyko, M.A., *See* Tanner, R.L., 3:26872
Li, K., Study of the mechanism of the hydrogen sulfide/dolomite reaction. Quarterly report, July 1977—October 1977, 3:25681 (FE—2408-5)
Liberov, L.G., *See* Rozovskii, A.Ya., 3:25967
Lichnerowicz, A., Gravitational waves, 3:27413
Lichtenberg, A.J., *See* Tuszewski, M., 3:27463
Lichtenberg, D.B., Interpretation of the Y (9.5) as evidence for another quark, 3:27185
Lieberman, B., *See* del Papa, C., 3:27102
Liewer, P.C., *See* Davidson, R.C., 3:27549
Lightman, A.J., *See* Fisher, E.R., 3:26730
Ligou, J., *See* Haldy, P.A., 3:27522
Likhterova, N.M., *See* Radchenko, E.D., 3:25771
Lilley, J.S., *See* Fitzgerald, D.H., 3:27365
Limon, P.J., *See* Humphrey, J.W., 3:26805
Lin, A.T., *See* Okuda, H., 3:27570
Lin, C.C., *See* Ching, W.Y., 3:26644
See Okuda, H., 3:27570
Lin, G.I., *See* Rozovskii, A.Ya., 3:25967
Lin, J.H., Improved black nickel coatings for flat plate solar collectors, 3:26072
Lin, R.J.H., Optimization of coatings for flat plate solar collectors, Phase II. Final report, 28 June 1976—27 June 1977, 3:26060 (COO—2930-12)
Lindberg, H.E., *See* Kennedy, T.C., 3:26851
Lindell, M.K., *See* Maynard, W.S., 3:25935
Lindemer, T.B., *See* Besmann, T.M., 3:26211
Lindquist, A.E., *See* Persse, F.H., 3:25686
Lindquist, J., Measurement of the angular correlation parameters in the β decay of polarized Λ hyperons, 3:27117
Lindroth, D.P., *See* Roepke, W.W., 3:25701
Lindseth, R.O., Seismic stratigraphic exploration: a new frontier, 3:25735
Lindsten, D.C., Decontamination of water containing chemical and radiological warfare agents by reverse osmosis. Technical report Jul—Nov 76, 3:26933 (AD-A—046203)
Lindstrom, P.J., Evidence against copious threshold pion production in heavy-ion collisions, 3:27122
Linn, G.W., Geochemical dispersion at the Mother Lode Mine near Kennicott, Alaska, 3:27015 (LA—6987-MS)
Linscott, B.S., *See* Das, S.C., 3:26126
Linville, B., Contracts and grants for cooperative research on enhanced oil and gas recovery and improved drilling methods. Progress review No. 12, 3:25745 (BERC—77/4)
Liptak, L., Development of an installation for safe disposal of concentrated liquid radioactive wastes of nuclear power plants, 3:25927
Lipton, R., *See* Chaney, D., 3:27121
Lisitano, G., Statistical distribution of high density discharges in the Pulsator Tokamak, 3:27491 (IPP—III/35)
Lisitchenko, V.V., Investigation of the transparency of the wave barrier for electron plasma waves in a magnetoactive plasma, 3:27586
Litke, A.M., *See* Scharre, D.L., 3:27113
Litovskii, E.Y., Thermal conductivity of refractory materials in a wide range of temperatures and rarefunctions of a gaseous medium, 3:26642
Litterst, R.F., BBCPLOT users manual, 3:27709 (UCID—17719)
Little, P.F., *See* Worsnop, P.A., 3:27596
Littlefield, L.J., Ultrastructure of the life cycle of rust fungi, 3:26979 (CONF-770504—, pp 95-128)
Littlejohn, G.J., *See* Cortez, J.R., 3:26824
Litunovskii, V.N., *See* Burtsev, V.A., 3:27460
Liu, C.S., Copper halide laser research. Final report, 3:26723 (AD-A—042484)
See Aamodt, R.E., 3:27548
See Chen, H.H., 3:27417
See Davidson, R.C., 3:27549
Livingston, A.E., *See* Berry, H.G., 3:27078
Livshits, B.R., *See* Taber, A.M., 3:25792
Livshits, M.A., Automation of a power block with combined circulation of a medium in the boiler under normal operating and emergency load-shedding conditions, 3:26176
Livshits, R.S., *See* Melik-Akhnazarov, T.Kh., 3:25778
Ljungdahl, *See* Peck, 3:26026
Lleres, J., Device for supporting the core of a fast neutron reactor, 3:26286 (ANL-Trans—1114)
Loch, T., *See* Cooper, F., 3:25684
Lockard, D.W., *See* Persse, F.H., 3:25686
Lockett, G.E., *See* Rennie, C.A., 3:26266
Lockridge, J.P., Beecher Island field, Yuma County, Colorado, 3:25833
Loeb, W.A., *See* Godfrey, A., 3:26447
Loeding, J.W., *See* Schora, F.C., 3:25625
Loehrke, R.I., *See* Sharp, M.K., 3:26079
Loehrke, R.O., Passive technique for enhancing thermal stratification in liquid storage tanks, 3:26080 (COO/4511—2, pp 43p, Paper 2)
Loftis, B., *See* Fontane, D.G., 3:26481
Logan, B.G., *See* Hammer, D.A., 3:27438
Logan, C.M., Compact beryllium target for production of fast neutrons, 3:26798
See Booth, R., 3:26789
Logan, R., Supplement to "Technical Documentation of Staff Procedures for Estimating Peak Demand", 3:26527
Logen, D., *See* Miller, J.M., 3:27379
Lohnert, G., *See* Mueller-Frank, U., 3:26262
Lohrding, R.K., Energy systems and statistics, 3:26505 (LA—6807-PR, pp 49-59)
Lokhmatikov, G.P., All-union red labor banner order-bearing trust, "spetsgidroenergomontazh", 3:25980
Lokke, W.A., *See* Jensen, R.V., 3:27627
Loktev, S.M., *See* Rozovskii, A.Ya., 3:25967
Lominadze, D.G., *See* Bizli, K.O., 3:27562
Lomovtsev, M.A., *See* Koroteev, A.S., 3:27534
Long, D., *See* Bretz, N., 3:27472
Loo, B.W., *See* Jaklevic, J.M., 3:26879
Look, G.W., *See* Fischbach, E., 3:27196
Loos, J.S., *See* Biswas, N.N., 3:27132
Lootens, D.J., *See* McEldowney, R.C., 3:25910
Lorazo, B., *See* Goulard, B., 3:27326
Lord Hinton of Bankside, Birth of Calder Hall, 3:26258
Loree, T.R., *See* Sze, R.C., 3:26737
Lorensen, L.E., *See* Johnson, W.L., 3:27682
Lorenzen, H., *See* Haddenhorst, H.G., 3:25887
Loss, F.J., Structural integrity of water reactor pressure boundary components. Progress report for period ending 28 February 1977, 3:26430 (AD-A—042219)
Louis, J.F., Combined cycle research program, January 1—March 31, 1977, 3:26145 (MIT—2295-T18-3)
Combined cycle research program. First annual report, July 1, 1976—June 30, 1977, 3:26146 (MIT—2295-T18-4)
Lourens, W., *See* Ronningen, R.M., 3:27373
Loveless, R.J., *See* Whitmore, J., 3:27139
Lozovskii, S.N., *See* Demirkhanov, R.A., 3:27452
Lu, K.T., High-lying levels in uranium atomic vapor near the ionization limit, 3:27061
See Fonck, R.J., 3:27048
Lubatti, H.J., *See* Ballagh, H.C., 3:27114
See Jonckheere, A.M., 3:27144
Luckey, D., *See* Halliwell, C., 3:27124
Luckhardt, S.C., *See* Davis, H.A., 3:27494
Ludemann, C.A., *See* Saltmarsh, M.J., 3:26794
Ludlam, T., Muon shield requirements for ISABELLE at 400 GeV/c, 3:26810 (BNL—23539)
Ludwig, P., *See* Geller, R., 3:27652
Lueke, D., *See* Piccolo, M., 3:27103
See Scharre, D.L., 3:27113
Luhning, R.W., *See* Nicholls, J.H., 3:25895
Lunt, A.R., *See* Cross, A., 3:26330
Lunt, R.R., *See* LaMantia, C.R., 3:25678
Lurie, N.A., *See* Lynn, J.W., 3:26652
Lushiku, E.M., Ellipsometry in the study of selective radiation: absorbing surfaces, 3:26063
Luttinger, J.M., Some functional inequalities, with application to Green's function, 3:27409
Lutz, H., *See* Wiesmann, H., 3:26602
Luzin, P.M., *See* Burgvits, G.A., 3:26140
See Parilov, V.A., 3:25709
Lynch, G.R., *See* Ballagh, H.C., 3:27114
Lynch, H.L., $e^+ e^-$ interactions, 3:27170 (SLAC-PUB—1643)
Lynn, J.W., Neutron-diffraction study of the staggered magnetization of $CuCl_2 \times 2D_2O$, 3:26652
Lyon, J.F., *See* Goldston, R.J., 3:27592
Lys, J.E.A., Charged-particle multiplicity distributions in 100-GeV/c pd, π^+ d, p-nucleon, and π-nucleon interactions, 3:27126
Screening correction for hadron-deuteron absorption cross sections near 200 GeV/c, 3:27231
Lytle, R.J., *See* Dines, K.A., 3:27006
Lyublin, B.V., *See* Burtsev, V.A., 3:27460

M

Macal, C.M., *See* Cohen, A.S., 3:26890
MacDonald, N., *See* Phelps, M.E., 3:26993
MacDonald, P.E., Response of unirradiated and irradiated PWR fuel rods tested under power-cooling-mismatch

conditions, 3:26443 (TREE-NUREG—1196)
Macfarlane, M.H., *See* Rehm, K.E., 3:27352
Machugovskii, N.B., *See* Vainshtein, Yu.D., 3:25725
Maciel, G.E., *See* Bartuska, V.J., 3:25668
MacKay, G.D.M., *See* Oren, J.J., 3:25813
Macrae, K.I., *See* Goldman, T., 3:27178
Madan, A.S., *See* Godfrey, A., 3:26447
Madansky, L., *See* Gilchriese, M.G.D., 3:27138
Madaras, R.J., *See* Scharre, D.L., 3:27113
Madell, J.T., Investigation of sodium-bonded carbide fuel assembly design, 3:26324
Madey, T.E., Evidence for the structures of adsorbed NH_3 and H_2O on RU(001), 3:25968 (AD-A—043330)
Maeck, W.J., Possible uranium—ruthenium method for measurement of ore age, 3:25903 (LA-UR—77-2863)
Maeda, H., *See* Kimura, H., 3:27467
Maejima, Y., *See* Takeda, S., 3:27595
Maekawa, H., *See* Seki, Y., 3:27622
Maekawa, S., *See* Saito, H., 3:27462
Magadeev, V.Sh., Corrosivity of flue gases from supercritical steam generators in operation on high-sulfur oil, 3:26155
Maglic, R.C., Induced magnetization density in α-uranium, 3:26605
Maguire, C.F., *See* Ronningen, R.M., 3:27374
Mahajan, O.P., *See* Kamishita, M., 3:25666
Mahan, W.M., *See* Daellenbach, C.B., 3:26832
Mahanthappa, K.T., Weak radiative decays of baryons in SU(4), 3:27191
Mahoney, J., *See* Kovar, D.G., 3:27351
Mahoney, J.R., *See* Murphy, B., 3:26193
Mai, W., *See* Agthe, G., 3:26346
Maisonnier, C., Preliminary results of the 1-MJ plasma focus experiment, 3:27496
Makarov, Yu.P., *See* Gladkikh, V.A., 3:25816
Makarova, V.V., *See* Kaliberdo, L.M., 3:26678
Maki, K., Study on plasma ignition of JAERI experimental fusion reactor, 3:27432 (JAERI-M—6876)
Maklakova, V.P., Stabilization treatment of return cooling water with phosphonates, 3:26158
Malashkin, I.I., *See* Styrikovich, M.A., 3:26707
Malaval, C., *See* Defauchy, J., 3:26285
Malden, M.L., Oil sands in situ projects continue at impressive rate, 3:25897
Malecki, P., *See* Jonckheere, A.M., 3:27144
Malhotra, S., Electrical design aspects for nuclear power plants, 3:26272
Malikov, M.M., *See* Ivanov, R.S., 3:26744
Malling, H.V., *See* Brown, M.M., 3:26994
Mallory, W.W., Fractured shale hydrocarbon reservoirs in southern Rocky Mountain basins, 3:25734
Malm, J.G., *See* Osborne, D.W., 3:26649
Managan, R.A., *See* Davies, K.T.R., 3:27380
Manakov, S.V., Pulsating solitons, 3:27284
Mandl, A., *See* Trainor, D., 3:26716
Manheimer, W.M., *See* Ott, E., 3:27665
Maniscalco, J.A., Applications of laser fusion, 3:27679 (UCRL—52000-77-8, pp 38-43)
See Hansen, L.F., 3:27681
Mann, A., *See* Barish, S.J., 3:27116
Mann, J.B., *See* Peek, J.M., 3:27072
Mann, T.L., *See* Nelms, L.W., 3:27636
Mann, W.A., *See* Briefel, E., 3:27140
Manne, A.S., ETA-MACRO: a model of energy-economy interactions, 3:26497 (EPRI-EA—592)
Mansouri, F., Superunified theories based on the geometry of local (super-) gauge invariance, 3:27273
Manukyan, Z.V., *See* Abramyan, L.O., 3:27105
Manzione, A.V., *See* Solomon, P.R., 3:25670
Marburger, J.H., Ir window studies. Final report, 1 September 1975—1 September 1976, 3:26725 (AD-A—042561)
March, R.H., *See* Heller, K., 3:27129
Marda, R.S., *See* Siler, W.C., 3:26227
Margolin, L.Y., *See* Batenin, V.M., 3:27475
Marinchek, Z., *See* Rassokhin, N.G., 3:26773
Markelov, S.S., Efficiency of hydraulic shipment of highly viscous oils in channels of rectangular cross section, 3:25810
Markiewicz, R.S., *See* Jeffries, C.D., 3:26646
Markov, B.G., Speed of ultrasound and thermophysical properties of the liquid metals of Sn, Cd, Bi and their binary alloys Cd—Bi and Sn—Bi, 3:26620
Markov, G.A., Flexible couplings between power plant main buildings and 500 kV open distribution units using lateral loops, 3:26201
Markushin, V.E., *See* Dal'karov, O.D., 3:27236
Marle, F., Some legal aspects of a LNG terminal establishment and operation in France, 3:25890
Marling, J., 1.05 to 1.44 μm tunability and performance of the cw Nd^{3+}:YAG laser, 3:26742
Marlow, W., *See* Tanner, R.L., 3:26872
Marmar, E.S., *See* Terry, J.L., 3:27446
Marr, D.R., *See* Chandler, J.C., 3:26321
Marriner, J.P., *See* Ballagh, H.C., 3:27114
Marrs, R.E., *See* Fisher, T.R., 3:27375
Marsh, S.F., Cation exchange of 53 elements in nitric acid, 3:26665 (LA—7083)
Marshak, H., *See* Fisher, T.R., 3:27375
Marshalkin, V.E., *See* Andreev, M.F., 3:27385
Marshall, J., *See* Prettie, C., 3:27041
Marshall, M., *See* Gilchriese, M.G.D., 3:27138
Marshall, P., Can world meet 300,000 tonnes supply challenge, 3:25925
Space propulsion system for terrestrial electricity, 3:26426
Marshall, W.F., Experiments with novel fuels for diesel engines, 3:26591 (BERC/TPR—77/8)
Stirling engine: an option for underground mines, 3:26577 (BERC/RI—78/3)
Martel, C., *See* Windingland, L.M., 3:26042
Martem'yanov, V.B., *See* Kobzarov, N.Y., 3:27219
Martin, A., Novel design for PWR pressure vessels, 3:26238
Martin, C.W., Corrosion control in gas processing plants which remove CO_2 and H_2S, 3:25768
Martin, F., *See* Barnett, R.M., 3:27194
Martin, J.B., *See* Zaidins, C.S., 3:26828
Martin, J.C., *See* Mullaney, P.F., 3:26961
Martin, J.F., *See* Scharre, D.L., 3:27113
Martin, J.P., *See* Lleres, J., 3:26286
Martin, M.J., *See* Kocher, D.C., 3:26991
Martin, N.C., Yeast mitochondrial DNA specifies tRNA for 19 amino acids. Deletion mapping of the tRNA genes, 3:26950
Martin, P., *See* Heller, K., 3:27129
Martin, R., *See* Oldson, J., 3:26094
Martin-Edingshaus, L., How Germany came to have nuclear energy: a stop half-way, 3:26336
Martinson, Z.R., *See* MacDonald, P.E., 3:26443
Marucci, G., *See* Cecchi, P., 3:26299
Marukhyan, V.Z., Application of statistical methods to obtain analytical characteristics of air condensing installations, 3:26138
Marushkin, V.M., *See* Polynovskii, Ya.L., 3:26159
Marx, M., *See* Humphrey, J.W., 3:26806
Maschke, A.W., *See* Mobley, R.M., 3:26795
Maskaev, A.S., *See* Danil'chenko, V.V., 3:26616
Maslyanskii, G.N., Catalytic reforming of naphtha cuts over polymetallic catalysts, 3:25772
Maslyn, R.M., Recognition of fossil karst features in the ancient record: a discussion of several common fossil karst forms, 3:25740
Mason, B.F., *See* Bache, T.C., 3:26850
Massey, R.S., Observations of stimulated Brillouin backscattering from a magnetically confined plasma, 3:27568
Masso, J.F., *See* Bache, T.C., 3:26850
Masson, P., Comments on the consequences of the setting up of a nuclear power plant, 3:26941
Masterson, D.M., Ice platforms for offshore drilling, 3:25827
Masterson, R., Analysis of the feasibility of implementing an implicit temporal differencing scheme in the SUPERENERGY code, 3:26279 (COO—2245-35TR)
Masuda, T., *See* Yamaguchi, T., 3:25866
Matheson, M.S., *See* Saunders, B.B., 3:26695
Mathews, T.A., Standardization facilitated by Duke's in-house capability for design and construction, 3:26235
Mathias, G., Steam turbines, 3:26367
Mathiesen, T.C., Risk management in marine transportation of LNG, 3:25844
Mathur, V.S., Charmed-meson decay in the massive-quark model, 3:27192
Phenomenological model for charmed meson decay, 3:27221
See Borchardt, S.R., 3:27179
Matinyan, S.G., *See* Asatryan, G.M., 3:27239
Matsuda, S., Application of automatic gas shield arc welding to the vertical butt joint of an oil storage tank shell, 3:25822
Matsumoto, A., Ion extraction from high electron temperature plasma and mass analysis, 3:27656 (IPPJ-DT—49)
Matsumoto, G., *See* Sato, O., 3:26390
Matsumoto, S., *See* Hori, K., 3:26781
Matsuoka, K., Magnetohydrodynamic instabilities in a current-carrying stellarator, 3:27559
Matsuzuru, H., Leaching behavior of strontium-90 in cement composites, 3:25942
Matta, J.E., Methane absorption in oil shale and its potential mine hazard. Report of investigations 1977, 3:25893 (PB—271219)
Methane emissions from gassy coals in storage silos, 3:25706 (BM-RI—8269)
Mattern, J., Method to prolong the fuel cycle in a boiling water reactor, 3:26226
Matthews, J.C., Control rod drives for nuclear reactors, 3:26409
Device for damping the control rod drive of a nuclear reactor, 3:26411
Matthews, J.R., *See* Bellamy, R.G., 3:26317
Mattox, D.M., Some chemical aspects of solar energy utilization, 3:26066
Matveev, V.A., Hydrodynamic model of collective resonances in hadronic matter, 3:27220
Matvienko, V.N., Heat field of petroliferous regions of Ciscaucasia, 3:26107
Matyugin, Yu.A., *See* Dolgopolov, S.G., 3:26755

Matzke, H., Fuel properties of advanced fuels (U,Pu)CN important for out-of-pile and in-pile kinetics, 3:26634
Mauger, J., *See* Bellus, F., 3:25842
Maurin, K., Mathematical physics and physical mathematics, 3:27419
Mavlyutov, M.R., *See* Shtur, V.B., 3:25753
Maxam, G.L., Degradation of EMP hardening devices, 3:26841 (SAND—77-0841)
Maximon, L.C., Electromagnetic interactions from 5 to 500 MeV and nuclear research: a position paper as of March 1977. Final report, 3:27168 (PB—270968)
Mayer, F.J., Electromagnetic structure resonances in inhomogeneous plasma layers, 3:27441
Maynard, C.W., *See* Avci, H.I., 3:27618
See Conn, R.W., 3:27601
Maynard, W.S., Public values associated with nuclear waste disposal, 3:25935 (BNWL—1997)
Mazumdar, S.K., *See* Bhattacharyya, T.K., 3:26058
Mazur, V.A., Alfven wave instability stabilization in a two-component tokamak, 3:27541 (IAE—2650)
McAlister, W.B., Oceanography, 3:27021 (TID—26712, pp 331-352)
McBeath, D.M., Gas-condensate fields of the Taranaki basin, New Zealand, 3:25825
McBride, J.B., *See* Hedrick, C.L., 3:27605
McCabe, J.T., *See* McGee, M.P., 3:25640
McCall, R.C., High energy photon response of moderated neutron detectors, 3:26820 (SLAC-PUB—1768)
Photon and electron response of silicon-diode neutron detectors, 3:26822
McCardell, R.K., *See* MacDonald, P.E., 3:26443
McCarthy, J., Angular distribution of the (π^-,π^0) reaction on ^{3}He at 200 to 290 MeV, 3:27319 (ORO—4043-37, pp 6)
Elastic scattering of π^{+-} on ^{3}He and ^{3}He, 3:27320 (ORO—4043-37, pp 8-11)
Electron scattering from ^{204}Pb, ^{206}Pb, ^{207}Pb, ^{208}Pb (Bates Linac), 3:27377 (ORO—4043-37, pp 34-38)
Electron scattering from ^{3}He and ^{4}He at high momentum transfer, 3:27378 (ORO—4043-37, pp 40-45)
Study of ^{3}He$(\pi^-,N)^2$H and ^{4}He$(\pi^-,N)^3$H at energies near the (3,3) resonance, 3:27318 (ORO—4043-37, pp 1-5)
See Bubb, E., 3:27314
See Day, D., 3:27322
McCarthy, J.S., Experiments on the nuclear interactions of pions and electrons. Progress report, December 1, 1976—November 30, 1977, 3:27097 (ORO—4043-37)
Threshold effects in the electrodisintegration of ^{3}He (Stanford Linac), 3:27321 (ORO—4043-37, pp 30-32)
McCartney, A.P., Prehistoric human occupation of the Rat Islands, 3:26898 (TID—26712, pp 59-113)
McCarty, P.L., *See* Healy, J., 3:26007
McCarty, R.D., *See* Haynes, W.M., 3:25881
McClellan, G., *See* Whitmore, J., 3:27139
McCormack, R.G., State of the art in fiber optics communications and data transfer. Interim report, 3:26660 (AD-A—042579)
See Sieber, D.C., 3:26659
McCormick, J.R., *See* Hopkins, R.H., 3:25990
McCracken, G.M., *See* Fielding, S.J., 3:27625
McCurry, D.C., *See* Chandler, J.C., 3:26321
McDaniel, P.J., Relation between fuel motion and detector response for in-core fuel motion detection systems, 3:26358 (SAND—77-0533C)
McDaniels, D.K., *See* Swenson, L.W., 3:27342
McDonald, A., *See* Budny, R., 3:27174
McDonald, G.E., Black chrome on commercially electroplated tin as a solar selective coating, 3:26061 (ERDA/NASA/1060—77/1)
McEldowney, R.C., Geology of uranium deposits in the Madison Limestone Little Mountain area, Big Horn County, Wyoming, 3:25910
McFadden, J., Northwest Energy Policy Project. Energy supply and environmental impacts: conventional energy sources. Study Module III-A final report, 3:26512 (NP—23054)
McFeely, F.R., *See* Ley, L., 3:26608
McGee, M.P., Review and evaluation of failures, maintenance, and operability data for CO_2 Acceptor Plant mechanical equipment, 3:25640 (MIT—78-TR3)
McGetchin, T.R., *See* Nitsan, U., 3:26117
McGowan, F.K., *See* Ronningen, R.M., 3:27373
McGrath, J.F., *See* Mayer, F.J., 3:27441
McGuire, E.J., Configuration-interaction effects on the L and M Auger spectra of Cu and Zn, 3:27049
See Feibelman, P.J., 3:26651
McGuire, H.E. Jr., *See* Spencer, R.R., 3:26012
McGuire, R.R., Properties of benzotrifuroxan, 3:26846 (UCRL—52353)
McHugh, J., *See* Vrancken, P.L.L., 3:25876
McIntosh, P.S., *See* Duvall, T.L. Jr, 3:27025
McKay, D., Real-time individual rationing as a response to an electricity shortage, 3:26525 (RAND-P—6006)
McKay, D.W., CP violation, radiative symmetry-breaking effects, and Higgs-particle and fermion masses, 3:27247
McKee, C.R., Permeability from single and multiple detonations in boreholes, 3:25702
McKenzie-Wilson, R.B., Cathode cooling systems for the magnetron and Penning H^- sources: a progress report of work at Brookhaven National Laboratory, 3:26801 (BNL—23654)
McKnight, J.S., *See* Wright, M.D., 3:26712
McKone, T.E., *See* Kastenberg, W.E., 3:26453
McKoy, B.V., *See* Rescigno, T.N., 3:27084
McLaren, R.J., *See* Duvel, W.A. Jr., 3:25680
McLeod, M.J., *See* Marsh, S.F., 3:26665
McMillan, F., Cryogenic tire granulation, 3:26573
McNally, J.R. Jr., Ignition parameter Tntau and the energy multiplication factor k for fusioning plasmas, 3:27523
McNeese, J.A., *See* Brenchley, D.L., 3:26873, 3:26874
McNeil, J.A., *See* Wallace, S.J., 3:27153
Mead, D., *See* Bush, T.W., 3:25619
Meadows, B.T., *See* Briefel, E., 3:27140
Meakin, J.D., Development of a thin film polycrystalline solar cell for large scale terrestrial use. First quarterly progress report, July 1, 1976—September 30, 1976, 3:25989 (DSE/2538—1)
Meckoni, V., Regional nuclear fuel cycle centres. IAEA study project, 3:25955
Medin, S.A., *See* Bityurin, V.A., 3:26537
Meger, R.A., *See* Davis, H.A., 3:27494
Mehner, A.S., *See* MacDonald, P.E., 3:26443
Meissner, F.F., *See* Dolly, E.D., 3:25828
Mel'nikov, V.N., *See* Zakhar'ev, B.N., 3:27311
Melaragno, M., Windpower, 3:26127
Melent'ev, L.A., Principles of nuclear district heating, 3:26544
Melik-Akhnazarov, T.Kh., Commercialization of new technology for two-stage cascade-countercurrent catalytic cracking, 3:25778
Mellottee, H., Extinction of metal fires, 3:26471
Men'shchikov, V.A., *See* Mukhina, T.N., 3:25791
Menchaca-Rocha, A., *See* Kovar, D.G., 3:27351
Mende, H., Evolution of radwaste evaporators in West Germany, 3:25932
Mendel, C.W., *See* Chang, J., 3:27670
Menousek, Z., Noncontact conductivity measurement, 3:27480
Mense, A.T., *See* Peng, Y.K.M., 3:27637
Mensinger, M., *See* Attari, A., 3:25641
Meoli, D.D., *See* Scheetz, E.J., 3:26242
Merezhko, V.P., *See* Shnitser, I.N., 3:26157
Merkle, K.L., *See* Averback, R.S., 3:26628
Merrell, T.R. Jr., Fishery resources of the western Aleutians, 3:26937 (TID—26712, pp 315-330)
Merriam, R.L., *See* Burke, J.C., 3:26048
Merrill, R.S., *See* Corbett, W.E., 3:25679
Merritt, M.L., Environment of Amchitka Island, Alaska, 3:26895 (TID—26712)
Geographic setting, 3:27004 (TID—26712, pp 1-11)
History, 1741—1967, 3:26922 (TID—26712, pp 115-140)
Metais, J.L., Irreversible process for Framatome, 3:26239
Meyer, E.L., *See* Giusti, E.V., 3:26413
Meyer, F.W., *See* Olson, R.E., 3:27076
Meyer, G.R., *See* Lewand, S.J., 3:25855
Meyer, H.O., *See* Fisher, T.R., 3:27375
Meyer, K., Integral representation of the GREEN function for time-dependent processes in one-group diffusion approximation, 3:26347
Meyer, P.A., Geophysical techniques used in uranium exploration, 3:25909
Meyer, W.T., *See* Gilchriese, M.G.D., 3:27138
See Ward, C.E.W., 3:27142
Meyer-Schuetzmeister, L., Gamma decay and lifetime measurements of the isomeric 19-/2 state in ^{43}Ti, 3:27347 (ANL—77-60, pp 80-82)
See Jackson, H.E., 3:27359, 3:27360
Meyer-Schutzmeister, L., *See* Elwyn, A.J., 3:27337
Michaelson, P.F., Toroidal field magnet system utilizing normal metal trimming coils, 3:27640 (UWFDM—225)
Michel, L., Simple mathematical models of symmetry breaking. Application to particle physics, 3:27249
Miertschin, G.N., Nuclear fuel element and method for its production, 3:26396
Mika, J., Singular perturbation method for evolution equations in Banach spaces, 3:27422
Mikaelian, K.O., Neutral-current effects in Bethe-Heitler pair production, 3:27175
Mikaelyan, A.L., *See* Glushchenko, N.F., 3:26760
Mikhailov, N.N., *See* Kochina, I.N., 3:25762
Mikhailov, S.Ya., *See* Livshits, M.A., 3:26176
Mikhajlovskii, A.B., Quasy - linear theory of satellite interaction of alphaparticles with Alfven waves in a tokamak, 3:27564 (IAE—2655)
To the nonlinear theory of alfven wave excitation in a tokamak, 3:27563 (IAE—2651)
See Mazur, V.A., 3:27541
Mikhajlovskij, A.B., *See* Bizli, K.O., 3:27562
Mikhalevich, A.A., *See* Zdanovich, N.N., 3:26383

Mikho, V.V., *See* Dmitrenko, Z.F., 3:26640
Mikic, B., Approximate method for predicting temperature distribution in wire wrapped fuel assemblies of a LMFBR, 3:26280 (COO—2245-37TR)
Milai, A.K., *See* Osipov, K.A., 3:26624
Milanese, M., *See* Bruzzone, H., 3:27493
Miley, G.H., *See* Hively, L.M., 3:27626
See Southworth, F.H., 3:27655
Miller, A., Chemical thermodynamic properties of ethylbenzene, 3:27414
Miller, C.E., *See* Holtz, R.E., 3:26432
Miller, D., Simultaneous measurement of the spin parameters P and C/sub N N/ in pp elastic scattering at 2, 3, 4, and 6 GeV/c, 3:27131
Miller, D.H., *See* Scharre, D.L., 3:27113
Miller, E.K., *See* Brittingham, J.N., 3:26776
Miller, F.X., Biostratigraphic correlation of the Mesaverde Group in southwestern Wyoming and northwestern Colorado, 3:25736
Miller, G., *See* Cantrell, E.L., 3:27583
Miller, G.A., Field theoretic treatment of π-nuclear scattering, 3:27391
Miller, G.J., *See* Woodard, J.B., 3:26033
Miller, J., *See* Roberson, P., 3:27130
Miller, J.H., Z^3 effect in the ionization cross section of argon by 1.2- and 2.0-MeV α particles, 3:27401
Miller, J.M., Pre-equilibrium α emission in reactions of 724-MeV ^{86}Kr with Au: A coincidence study of direct and evaporation mechanisms, 3:27379
Miller, R.B., *See* Ellis, A.E., 3:26445
Miller, R.L., *See* Krakowski, R.A., 3:27454
Miller, R.R., *See* McCarthy, J.S., 3:27321
Miller, T.B., *See* Shay, W.M., 3:26444
Miller, W.F. Jr., *See* Seed, T.J., 3:27616
Millican, R.W., Nuclear weapon effects uncertainties in tactical warfare. Final report, 2 June—3 Nobember 1975, 3:26854 (AD-A—043684)
Mills, M.E. Jr., *See* Carlin, J.T., 3:25747
Milner, W.T., *See* Wells, J.C. Jr., 3:27357
Milora, S.L., *See* Foster, C.A., 3:27664
Minaev, P.V., *See* Batenin, V.M., 3:27475
Minakata, S., *See* Murata, Y., 3:25868
Minehart, R.C., *See* Comiso, J.C., 3:27333
See McCarthy, J., 3:27320
See McCarthy, J.S., 3:27097
Miner, R.S. Jr., Hydrogenation of hexene over platinum on alumina vs. platinum in a Na-Y zeolite, 3:26684
Mingle, J.O., *See* Chen, Y.F., 3:26250
Minkiewicz, V.J., *See* Glinka, C.J., 3:26612
Minsker, K.S., Polymerization (oligomerization) of isobutyl from eneommercial c_4 hydrocarbon fraction in the presence of soluble organoaluminum catalysts, 3:25776
Miranowski, J.A., *See* Smith, R.J., 3:26020
Mirels, H., *See* Turner, E.B., 3:26722
Mirnov, V.V., *See* Vekshtejn, G.E., 3:27458
Mironov, V.Ya., Application of CDP-stacked tapes to seismic exploration, 3:27012
Mishchenko, T.V., Angular distribution of electrons emitted in electron-impact ionization of helium atoms, 3:27083
Mishima, J., *See* Oscarson, E.E., 3:26989
Mitchell, J.T.D., Tokamak reactor with servicing capability, 3:27699 (EUR—5602, pp 429-440)
Mitchell, K.W., Computer analysis of resistance and non-uniform illumination effects on concentrator solar cells, 3:25995 (SAND—77-1269C)
Mitra, S.K., *See* Sjoedin, S., 3:27579
Mitra, S.S., Absorption of electromagnetic radiation in the transparent regime of solids. Final report, 14 October 1974—13 October 1975, 3:26658 (AD-A—042226)
Mitrofanov, M.G., *See* Varshaver, E.M., 3:25788
Mittleman, J., OPC-3000 coalescing plate oil/water separator evaluation. Technical memo, 3:25799 (AD-A—046123)
Miyamoto, K., Possibility of medium energy neutral beam injection into stellarator reactor, 3:27430 (IPPJ—252)
Stress analysis of supporting tube of helical winding in stellarator device, 3:27632 (IPPJ-T—25)
See Matsuoka, K., 3:27559
Mizutani, T., Coupled channel theory of pion—deuteron reaction applied to threshold scattering, 3:27317
Mjolsness, R.C., *See* Ramshaw, J.D., 3:26765
Mlekodaj, R.L., *See* Cole, J.D., 3:27370
Mobley, R.M., Neutralization of positive particle beams by electron trapping, 3:26795 (BNL—23655)
Moeller, W., *See* Agthe, G., 3:26346
Moffa, P.J., Folding model description of heavy ion inelastic scattering, 3:27328
Moffitt, R.L., Bush dome model: computing movement of injected crude helium. Software, 3:25882 (PB—269450)
Mohapatra, R.N., Currents, quarks, and gluons, 3:27162
Gauge theories of weak interactions with left-right symmetry and the structure of neutral currents, 3:27250
Mohaupt, U.H., *See* Yie, G.G., 3:26704
Mohri, A., Toroidal equilibrium of reverse field pinch, 3:27501 (CLM-R—164)
Moir, R.W., Mirror reactor studies, 3:27602
See Barr, W.L., 3:27666
Moiseeva, L.N., Reliability indices of power units following their enlargement, 3:26128
Molinari, A., *See* Broglia, R.A., 3:27096
Mollet, W., Coherent dissociation of neutrons on nuclei at 100—300 GeV/c, 3:27123
See Chaney, D., 3:27121
Molnar, Zs., *See* Bereznai, T., 3:26249
Moltz, D.M., *See* Cerny, J., 3:26803
Momota, H., Theoretical investigations of lower hybrid resonance heating in a tokamak, 3:27433 (JAERI-M—6964)
Monahan, J.E., *See* Elwyn, A.J., 3:27337
Monakhov, Yu.S., *See* Gonchar, v.K., 3:26179
Monastyrskaya, A.R., *See* Levental', G.B., 3:26534
Mondt, J.P., *See* Davidson, R.C., 3:27549
Moneti, G.C., *See* Briefel, E., 3:27140
Monoszon, N.A., *See* Glukhikh, V.A., 3:27645, 3:27650
Monroy, J., *See* Bartlett, D.F., 3:27258
Monsay, E.H., Vacuum structure of the two-dimensional Higgs model, 3:27260
Montano, P.A., Moessbauer spectroscopy of iron compounds found in West Virginia coals, 3:25671
Montet, A., LNG transportation by road tank trailers, 3:25873
Montgomery, D., *See* Fyfe, D., 3:27567
Monticello, D.A., *See* White, R.B., 3:27644
Mook, H.A., Re-examination of the inelastic neutron scattering in tetrathiafulvalene-tetracyanoquinodimethane (TTF-TCNQ), 3:26650
Moon, H.W., *See* Pohlenz, J., 3:26975
Moon, R.L., *See* James, L.W., 3:26000
Moor, K.S., ^{239}Pu and ^{241}Am contamination of small vertebrates in NAEG study areas of NTS and TTR, 3:26915 (NVO—171, pp 193-217)
Moor, S.S., *See* Barreto, F., 3:25662
Moore, C.F., *See* Iversen, S., 3:27335
See Swenson, L.W., 3:27342
Moore, P.A., *See* Clemons, V.D., 3:26440
Mooring, F.P., *See* Elwyn, A.J., 3:27337
Moos, W.H., *See* Terry, J.L., 3:27446
Morales, R., Development of sampling and analytical methods for carcinogens. Progress report, January 1—September 30, 1976, 3:26997 (LA—7058-PR)
Moreira, J.R., *See* Euteneuer, H., 3:27343
Morgan, J.D. III, Positivity of an integral connected with the helium atom problem, 3:27408
Morgan, P.D., *See* Maisonnier, C., 3:27496
Mori, Y., Decomposition rate of nitric oxide on alumina surface in the temperature range 920 to 1220°K, 3:26679
See Kuroda, Y., 3:26351
Morikawa, J., *See* Inoue, N., 3:27453
Morin, J., *See* Hourst, J.B., 3:26792
Morishita, O., Stress analysis of the bellows and its connection with a thick ring of the vacuum vessel, 3:27702 (JAERI-M—6822)
Morita, Y., *See* Kimura, T., 3:25785
Moriyasu, K., *See* Ballagh, H.C., 3:27114
See Jonckheere, A.M., 3:27144
Moroz, A.M., *See* Bursian, N.R., 3:25793
Morozov, G., Comparative evaluation of the technical and economic indices of MHD and thermionic add-on units for steam-turbine power plants, 3:26150 (JPRS—69811)
Morozova, S.G., *See* Basov, Yu.G., 3:26754
Morrey, J.R., *See* Franz, J.A., 3:25669
Morris, C.L., *See* Iversen, S., 3:27335
Morris, S.C., Comparative effects of coal and nuclear fuel on mortality, 3:26871 (BNL—23579)
Morris, W.F., *See* Ames, H.S., 3:27017
Morrison, P.R., Sea otter metabolism and heat economy, 3:26970 (TID—26712, pp 569-577)
Morrow, L.H., *See* Shuler, L.E., 3:26840
Morse, W.M., *See* Whitmore, J., 3:27139
Moss, L., *See* del Papa, C., 3:27102
Mossadeghi, T., Prospects of LNG export and its limitations, 3:25847
Motley, R.W., *See* Bernabei, S., 3:27582
Motohashi, N., *See* Okano, T., 3:26951
Motojima, K., Improvement on removal of radio-cobalt from waste water by ferric hydroxide coagulation-flocculation process using diethyldithiocarbamate, 3:25931
Motulevich, G.P., *See* Golovashkin, A.I., 3:26626
Mougniot, J., *See* Delpeyroux, P., 3:26304
Mowrey, M.F., Effects of high temperature on infections of E. coli B by bacteriophage T4D and its mutant in gene regA, 3:26976 (UR—3490/LCP-2)
Moynihan, C.T., *See* Kilroy, W.P., 3:26488
Mozgovoi, A.G., *See* Petukhov, V.A., 3:26617, 3:26618
Mozley, R., *See* del Papa, C., 3:27102
Mueller, A., *See* Agthe, G., 3:26346
Mueller, F., *See* Hildebrandt, E., 3:26385
Mueller, G.P., A boltzmann transport code for ion penetration in matter. Memorandum report, 3:27399 (AD-A—043502)
Mueller, J.J., Evaluation of materials for use in letdown valves and coal feed pumps for coal liquefaction service. Final report, 3:25647 (EPRI-AF—579)
Mueller, M.H., *See* Maglic, R.C., 3:26605
Mueller-Frank, U., Pebble bed reactor with one-zone core, 3:26262
Muenich, M., *See* Koeppendoerfer, W., 3:27535
Mukhina, T.N., Pyrolysis of petroleum fractions as the main source of raw material for the petrochemical industry, 3:25791
Mukhlenov, I.P., Removal of sulfur dioxide from gases using activated carbon at elevated temperatures, 3:26668
Mukosei, V.I., *See* Egerev, V.V., 3:25972
Mullaney, P.F., Automated cancer-cell sorting and analysis. Progress report,

June 1—November 30, 1977, 3:26961 (LA—7076-PR)
Mulot, P., *See* Allain, A., 3:26288
Mungan, I., Experimental investigations of buckling and stability determination of cooling tower shells, 3:26134
Munno, F.J., *See* Carbajo, J.J., 3:26448
Munro, J.K., Corrections and revisions to the FORTRAN IV version of the Wisconsin Hydrologic Transport Model, 3:27003 (ORNL/NSF/EATC—29)
Muradyan, E.M., *See* Abramyan, L.O., 3:27105
Murasaki, T., *See* Kasuya, K., 3:27530
Murata, Y., Transfer system of completed spherical tank for LNG carrier, 3:25868
Murphy, B., Energy consumption of environmental controls: fossil fuel, steam electric generating industry. Final report, 3:26193 (PB—273019)
Murphy, C.T., *See* Lys, J.E.A., 3:27126
See Raja, R., 3:27128
Murphy, M.J., *See* Davids, C.N., 3:27355
Murphy, W.F., *See* Holtz, R.E., 3:26432
Murray, D.K., Coal and methane gas in the southeastern part of the Piceance Creek basin, Colorado, 3:25688
Murray, F.X., Divestiture: the pros and cons, 3:26520
Murray, J.R., *See* Goldhar, J., 3:26743
Musgrave, B., *See* Barish, S.J., 3:27116
See Derrick, M., 3:27125
See Ward, C.E.W., 3:27142
Mutchler, J., *See* Cooper, F., 3:25684
Myers, B.F., Roscoe manual. Volume 14B. Midlatitude density profiles of selected atmospheric species. Final report, 2 March 1974—28 February 1975, 3:26852 (AD-A—043499)
Myers, J.E., *See* Bevilacqua, F., 3:26406
Myers, W.A., *See* Nethaway, D.R., 3:27381
Mynatt, F.R., December 1977 monthly highlights for Office of Nuclear Regulatory Research Programs at Oak Ridge National Laboratory, 3:26441 (ORNL/NUREG/TM—182)
Mync, L., Analysis of core disruptive accidents in carbide-fueled LMFBRs, 3:26475
Mysak, I.S., Effectiveness of high-sulfur oil combustion within range of loads in the furnace of the TGMP-314 steam generator, 3:26154

N

Nachtmann, O., Phenomenology of electron positron annihilation into hadrons, 3:27183
Nadenkova, L.S., *See* Shpak, V.S., 3:26361
Naele, S.R., *See* Moor, K.S., 3:26915
Nagami, M., *See* Kimura, H., 3:27613
Nagamiya, S., Proton and pion spectra at large angles in relativistic heavy-ion collisions, 3:27332 (LBL—670)
Nagashima, T., *See* Imai, T., 3:27566
Nagata, M., Field theory, 3:27418
Nagel, D.J., *See* Johnson, D.J., 3:27397
Nagy, O., Experiments in connection with control of boron acid concentration by ion exchange in Hungary, 3:26408
Nakabayashi, N., *See* Kimura, T., 3:25785
Nakamura, H., Heat analysis of the magnetic limiter plate for JT-60, 3:27614 (JAERI-M—7013)
Nakamura, Y., Dielectronic recombination of carbon, oxygen and iron in low-density and high-temperature plasmas, 3:27505 (JAERI-M—7019)
Observation of electron-ion instability in counterstreaming ion beams and plasma system, 3:27573
Nakasa, H., Application of acoustic emission techniques to integrity assessment of nuclear reactor components, 3:26371
Nakatani, R.E., *See* Simenstad, C.A., 3:26927
Nakvi, S.M., *See* Nikitin, S.A., 3:26625
Namba, S., *See* Miner, R.S. Jr., 3:26684
Namboodiri, M.N., *See* Stokstad, R.G., 3:27336
Nambu, Y., Strings, vortices, and gauge fields, 3:27211
Namenson, A.I., *See* Smither, R.K., 3:27372
Nanopoulos, D.V., *See* Barger, V., 3:27188, 3:27189, 3:27195
Napier, J.C., *See* Ward, M.E., 3:26152
Narayan, J., *See* Chen, Y., 3:26596
Nardi, V., *See* Bostick, W.H., 3:27483
Nasibov, N.A., Self-alignment in thrust bearings, 3:25760
Natowitz, J.B., *See* Stokstad, R.G., 3:27336
Naughton, J.J., Incrustations and fumarolic condensates at Kilauea volcano, Hawaii: field, drill-hole and laboratory observations, 3:26123
Nawrocki, A.D., *See* Zuclich, J.A., 3:26999
Nayak, U.P., Analytical comparison of the irradiation behavior of fast reactor carbide and oxide fuel pins, 3:26319
Nayfeh, M.H., *See* Hurst, G.S., 3:27062
Neale, W.W., *See* Raja, R., 3:27128
Nealey, S.M., *See* Maynard, W.S., 3:25935
Nease, D., *See* Barish, B.C., 3:27115
Nedopekin, V.G., *See* Andreev, V.N., 3:27384
Nedorezov, V.G., Experimental investigation of spontaneously fissile isomers, 3:27386
Nedospasov, A.V., *See* Ivanov, R.S., 3:26744
Nekrasov, F.M., *See* Demirkhanov, R.A., 3:27452
Nekrasov, V.G., Effect of regime parameters of boiler operation on abrasive properties of Ekibastuz coal ash, 3:26167
Nelms, L.W., Large coil test facility conceptual design report, 3:27636 (ORNL/TM—6032)
Nelson, D.B., *See* Peng, Y.M., 3:27437
Nelson, P.A., Batteries for utility load leveling, 3:26486
See Ackerman, J.P., 3:26542
Nelson, V.A., *See* Seymour, A.H., 3:26934
Nelson, W.R., Similarities among the radiation fields at different types of high energy accelerators, 3:26796 (SLAC-PUB—1805)
Nemtsev, V.A., *See* Zdanovich, N.N., 3:26383
Nesterenko, V.B., *See* Shpak, V.S., 3:26361
See Zdanovich, N.N., 3:26383
Nethaway, D.R., Fission of ^{240}Pu with 14.8-MeV neutrons, 3:27381
Netherton, R., *See* Dengler, L.A., 3:26119
Netsch, E., *See* Tratz, H., 3:26224
Nettles, W.G., *See* Cole, J.D., 3:27370
Neufeld, R.D., Bio-oxidation of aqueous cyanogens typical of Synthane gasifier by-product water. Progress report, September 1, 1977—November 30, 1977, 3:26947 (COO/4502—1)
Neuffer, D.V., Calculation of parity-nonconserving effects in forbidden M1 transitions in cesium, 3:27054
Neuhold, J.M., *See* Valdez, R.A., 3:26924
Neuman, C.P., *See* Hetyei, S.A., 3:26040
Nevius, D.R., *See* Johnson, A.C., 3:26522
Newton, A.A., *See* Butt, E.P., 3:27631
Newton, C.E., Performance tests of the ORGDP radiation detection instruments, 3:26821 (Y/DD—215)
Ng, J.N., *See* Chang, L.N., 3:27187
Ng, Y.J., Generalization of the quark-confining string, 3:27157
See DeGrand, T.A., 3:27176
Nguyen, V.K., *See* Berger, D., 3:27520
Nicholls, J.H., Heavy oil sand in-situ pilot plants in Alberta (past and present), 3:25895
Nichols, D.A., *See* Russell, O.R., 3:26921
Nichols, M.C., Direct contact heat exchange for latent heat-of-fusion energy storage systems, 3:26483 (SAND—77-8665)
Nickerson, G.M., Safety aspects of carbide irradiations in FTR driver positions, 3:26476
Nickerson, R.A., *See* Booth, R., 3:26789
See Logan, C.M., 3:26798
Nicks, R., *See* Burn, K., 3:27609
Nield, K., *See* Miller, D., 3:27131
Nielsen, T., *See* Gundtoft, H.E., 3:26388
Niemann, H.J., Risk analysis for natural-draught cooling towers under wind load, 3:26135
Niemczyk, T.M., *See* Ettinger, D.G., 3:26648
Nieminen, R.M., *See* Jena, P., 3:26604
Niesz, D.E., *See* Schorr, J.R., 3:26882
Nigmatulin, V.I., *See* Ivandaev, A.I., 3:26771
Nihei, H., *See* Inoue, N., 3:27453
Nikitin, S.A., Scattering of conduction electrons by spin disorder in rare-earth dysprosium—yttrium alloys, 3:26625
Nikitin, Y.P., *See* Volkov, G.G., 3:27237
Nikolin, G.Ya., *See* Beresnevich, P.V., 3:25704
Nikonova, A.G., *See* Kovalev, G.I., 3:25787
Ninomiya, H., *See* Kameari, A., 3:27635
See Nakamura, H., 3:27614
Nissen, D.A., Low-temperature oxidation of calcium by water vapor, 3:26681
Nitikin, A.K., Selection of the optimum height-diameter ratio to be used in low-pressure methanol synthesis, 3:25965
Nitsan, U., Cooling rate and geothermal potential of silicic plutons: effect of size, shape, depth, and thermal parameters (abstract), 3:26117
Niwa, S., *See* Hori, K., 3:26196
Nix, J.R., *See* Davies, K.T.R., 3:27380
Nobili, A., *See* Calza-Bini, A., 3:26302
See Cecchi, P., 3:26299
Nocentini, A., *See* Engelmann, F., 3:27521
Noelker, A., *See* Bretfeld, H., 3:26360
Noguchi, K., Chemical components of hot springs in Nagano Prefecture, 3:26102
See Suzuki, K., 3:25834
Noles, G.T., *See* Granoff, B., 3:25663
See Thomas, M.G., 3:25664
Noll, S., *See* Ben-David, S., 3:26051
See Roach, F., 3:25985
Nomura, S., Japanese development program for advanced LMFBR fuels, 3:26297
Nomura, Y., *See* Nakamura, Y., 3:27573
Norcross, W.R., Industrial application of fluidized-bed combustion: Phase I. Quarterly report, July 1—September 30, 1977, 3:26779 (FE—2473-15)
Nordyke, M.D., *See* Ledbetter, G.P., 3:26856
Norman, E.B., *See* Davids, C.N., 3:27355
Noro, K., *See* Nomura, S., 3:26297
Northrop, T.G., Extensions of guiding center motion to higher order, 3:27508
Norton, D., Transport phenomena in hydrothermal systems: the nature of porosity, 3:26083
Transport phenomena in hydrothermal systems: cooling plutons, 3:26084
Nosov, B.N., *See* Livshits, M.A., 3:26176
Novikov, M.A., *See* Gusev, M.E., 3:26752
Novikova, L.P., *See* Savin, V.I., 3:26545
Novitskii, N.V., *See* Alekhnovich, A.N., 3:25675
Noyes, R.C., *See* Caspersson, S.A., 3:26323
Nuckolls, J.H., Laser fusion targets, 3:27675 (UCRL—52000-77-8, pp 5-12)
Nueesch, P., *See* Bereiter, R., 3:26151
Nunan, G.A., *See* Johnson, A.C., 3:26522

Nunnally, C., 1K delay line digitizer, 3:26830 (LBL—7215)
Nunziato, J.W., Thermal ignition time for homogeneous explosives involving two parallel , 3:26847
See Kennedy, J.E., 3:26848
Nuttall, A., *See* Anderson, M., 3:26814
Nylund, J., *See* Solberg, D.M., 3:25843

O

O'Brien, W.G., Excess Gibbs free energy and the activity coefficients of the $Nd(NO_3)_3$—HNO_3—H_2O system at 25°C, 3:26671 (IS-M—125)
O'Clair, C.E., Marine invertebrates in rocky intertidal communities, 3:26926 (TID—26712, pp 395-449)
O'Conner, J.K., *See* Kursh, S.J., 3:26053
O'Farrel, P.M., *See* Raj, P.P.K., 3:26929
O'Neil, R.R., EXCEDE II. Environmental research papers, 3:27035 (AD-A—042491)
O'Neill, T.B., Biodegradation of oil in seawater for naval pollution control. Final report 1974—1976, 3:25798 (AD-A—042375)
O'Raifeartaigh, L., Broken gauge and scale invariance, 3:27253
O'Shea, K.R., *See* Lushiku, E.M., 3:26063
Oakes, R.J., *See* Mikaelian, K.O., 3:27175
Oberle, R.D., *See* Duncan, D.A., 3:25656
Obst, A., *See* Iversen, S., 3:27335
Odian, A., *See* del Papa, C., 3:27102
Odintsov, V.N., Constructive and technological aspects of vacuum system design for demonstration thermonuclear reactor Tokamak, 3:27700 (EUR—5602, pp 471-481)
Offman, P.E., Relations between the depth and surface tectonics of the Urals and Priurals and their significance in searching for oil and gas, 3:25727
Oganesyan, Y.T., *See* Bugrov, V.N., 3:27382
Ogata, Atsushi, *See* Aikawa, Hiroshi, 3:27468
Ogawa, K., Preliminary report of study on the gravimetric monitoring at the Takinoue geothermal area, Iwate Prefecture. Study on the geothermal system of geothermal area: the 4th report, 3:26095
Ogden, J.M., *See* Davidson, R.C., 3:27549
Ogiachi, N.N., Researching an alternate synthesis of triaminotrinitrobenzene, 3:26683 (UCRL—13808)
Oh, B.Y., *See* Raja, R., 3:27128
See Whitmore, J., 3:27139
Ohasa, K., *See* Matsuoka, K., 3:27559
Ohashi, A., *See* Yanaida, K., 3:25696
Ohkawa, T., *See* Prater, R., 3:27543
Ohkubo, K., Distinctive catalysis by phosphonium and sulfonium compounds in low-temperature liquid-phase hydrocarbon oxidation, 3:26688
Ohlsen, G.G., *See* Haglund, R.F. Jr., 3:27324
Ohmart, R.D., *See* Bennett, W.W., 3:26943
Ohshika, T., *See* Itoh, S., 3:26589
Ohta, M., *See* Morishita, O., 3:27702
See Nakamura, H., 3:27614
Ohtake, K., *See* Mori, Y., 3:26679
Ohtsuka, H., *See* Kimura, H., 3:27467, 3:27613
Ohtsuka, Y., *See* Murata, Y., 3:25868
Okada, J.T., *See* Brittingham, J.N., 3:26776
Okada, S., *See* Sato, K.N., 3:27427
Okada, Y., *See* Hori, K., 3:26781
Okamoto, M., *See* Momota, H., 3:27433
Okamoto, T., *See* Hori, K., 3:26196
Okano, T., Electronic properties of n-heteroaromatics, LVII. Intermolecular interaction of the anti-tumor dye nile blue A and deoxyribonucleic acid (DNA), 3:26951 (LA-tr—77-66)
Okorokov, V.V., *See* Il'lna, I.L., 3:27402
Okrent, D., *See* Kastenberg, W.E., 3:26453
See Salem, S.L., 3:26472
Oks, E.A., Stark profiles of hydrogen lines in a plasma with a low-frequency turbulence, 3:27487
Oku, K., *See* Yamaguchi, T., 3:25866
Okubo, S., Consequences of quark-line (Okubo-Zweig-Iizuka) rule, 3:27218
Constraint on color gauge groups, 3:27263
Gauge groups without triangular anomaly, 3:27262
Okuda, H., Quasi-neutral particle simulation model with application to ion wave propagation, 3:27570
Okuno, K., *See* Matsumoto, A., 3:27656
Ol'khovskii, I.P, *See* Bulgakov, B.M., 3:26761
Ol'kov, P.L., Combined process of partial deparaffination and de-oiling of solid hydrocarbons, 3:25769
Oldson, J., In situ thermal conductivity measurements for heat flow determinations in marine and lacustrine environments (abstract), 3:26094
Olesen, P., Fermionic representation of the infrared behavior of pure Yang—Mills fields, 3:27289
Olien, N.A., Superconducting devices and materials. A literature survey issued quarterly, July—September 1977. Issue No. 77-03, 3:26710 (NP—23061)
Oline, W.F., *See* Adams, O.C., 3:25737
Oliphant, W.F., *See* Johnson, D.J., 3:27397
Oliver, A.J., *See* Grader, R.J., 3:27060
Oliver, G.D. Jr., *See* McCall, R.C., 3:26822
Ollier, H., *See* Delpeyroux, P., 3:26304
Olmer, C., *See* Kovar, D.G., 3:27351
Olness, J.W., *See* Warburton, E.K., 3:27346
Olson, D.P., *See* Anastasia, L.J., 3:25624
Olson, J.J., Mechanized longwall mining, a review emphasizing foreign technology. Information circular 1977, 3:25695 (PB—272699)
Olson, N.J., *See* Kurtz, R.J., 3:26442
Olson, R.A., Closed-cycle rare-gas electrical-discharge laser. Final report, 1 June 1973—30 September 1976, 3:26715 (AD-A—042233)
Olson, R.E., Electron loss by atomic and molecular hydrogen in collisions with $^3He^{++}$ and $^4He^+$, 3:27076
Omberg, R.P., *See* Chandler, J.C., 3:26321
Omel'chenko, A.Ya., *See* Dushin, L.A., 3:27590
Omes, S.P., Evaluation of porosity boundaries of reservoirs in Efremovskoye gas field, 3:25830
Onishchenko, V.V., *See* Demirkhanov, R.A., 3:27452
Ono, F., *See* Ozaki, K., 3:25618
Opdenaker, A., *See* Rose, D., 3:26312
Oradzhanov, G.A., *See* Krainov, V.N., 3:25971
Ore, F.R. Jr., How to compute determinants compactly, 3:27278
Orechwa, Y., *See* Barthold, W.P., 3:26322
Oren, J.J., Electrolyte and pH effect on emulsion stability of water-in-petroleum oils, 3:25813
Oren, L., Trapping and removal of oxygen in tokamaks, 3:27628
Orlov, A.F., *See* Osipov, K.A., 3:26624
Orphanos, L., *See* McCarthy, J., 3:27318, 3:27319
Orthel, J., *See* Ballagh, H.C., 3:27114
Osborn, R.K., *See* Mayer, F.J., 3:27441
Osborne, D.W., Heat capacity, entropy, and Gibbs energy of technetium hexafluoride between 2.23 and 350 K; magnetic anomaly at 3.12 K; mean β energy of ^{99}Tc, 3:26649
Osborne, J.W., *See* Gruber, H.E., 3:26986
Oscarson, E.E., Detailed accident analysis for the high level waste preparation phase of the commercial nuclear waste vitrification project, 3:26989 (BNWL—2207)
Oshchepkova, T.B., *See* Zinger, N.M., 3:26547
Osher, J.E., Alternate approaches to D-beam production, 3:27659 (UCID—17672)
See Booth, R., 3:26789
See Damm, C.C., 3:27531
Osipov, K.A., Oscillations of properties of thin superconducting films with varying coating thickness, 3:26624
Osipov, L.N., *See* Radchenko, E.D., 3:25771
Osipova, L.I., *See* Stekhun, A.I., 3:25820
Ostapchenko, E.P., *See* Zabortseva, T.A., 3:26751
Otani, S., *See* Matsumoto, A., 3:27656
Othmer, S., *See* Srour, J.R., 3:26836
Ott, E., Cross-field injection, propagation, and energy deposition of intense ion beams with application to tokamak plasma heating, 3:27665
Otterberg, J.E., Neutron dose monitoring using a multiple lithium fluoride TLD badge, 3:26462
Otto, K., *See* Osborne, D.W., 3:26649
Otway, H.J., Risk assessment and the social response to nuclear power, 3:26416
Ovcharenko, N.G., *See* Polynovskii, Ya.L., 3:26159
Overseth, O.E., *See* Heller, K., 3:27129
Ovsyannikov, V.A., *See* Burtsev, V.A., 3:27460
Owen, P.T., *See* Ensminger, J.T., 3:25938
Owen, W., *See* Healy, J., 3:26007
Owens, E.H., Contingency planning for the impact of oil spills in different coastal environments of Canada. Technical report, 3:26905 (AD-A—043713)
Ozaki, K., Coking tests for Japanese coal blends by preheated-charging method, 3:25618
Development of high temperature dust collector. I, 3:26569
Ozaki, N., Cost analyses of uranium enrichment by laser isotope separation process, 3:25920
See Yamada, K., 3:25918, 3:25919
Ozbek, H., Viscosity of aqueous sodium chloride solutions from 0 to 150°C, 3:26114 (LBL—5931)

P

P'yankov, V.Ya., *See* Belyakov, Yu.S., 3:26199
Pack, J.L., *See* Liu, C.S., 3:26723
Paetz, E., *See* Haferkamp, D., 3:26382
Paine, D., Applications to waste management operations, 3:25951 (PNL—2253, pp 8.1-8.22)
Impact of radioactive waste management operations, 3:25949 (PNL—2253, pp 6.1-6.13)
See Cataldo, D.A., 3:25948
Pais, A., *See* Georgi, H., 3:27151
Pak, N.K., Decay of metastable vacuums in the massive Schwinger model, 3:27271
Pak, P.M., *See* Tsybulevskii, A.M., 3:25773
Palazzi, G., *See* Campolunghi, F., 3:26184
Palmer, R.G., *See* Dobson, J.E., 3:26932
Palmer, W.F., *See* Hietarinta, J., 3:27245
Palmisano, J.F., Ecological interactions involving the sea otter, 3:26928 (TID—26712, pp 527-567)

See Lebednik, P.A., 3:26925
Palms, J.M., L shell fluorescence yields and Coster-Kronig transition probabilities using radioactive sources. Final report, 3:27056 (AD-A—042228)
Palrang, M.T., *See* Dean, N.R., 3:26815
Panarina, A.S., *See* Ol'kov, P.L., 3:25769
Pandey, K.C., *See* Feibelman, P.J., 3:26651
Pannikova, R.F., *See* Maslyanskii, G.N., 3:25772
Panov, A.N., *See* Pavlov, G.G., 3:27529
Paoloni, F.J., *See* Bernabei, S., 3:27582
Papadopoulos, K., Formation of positive slope on electron runaway distribution in tokamaks, 3:27524
See Hammer, D.A., 3:27438
Papaloizou, J.C.B., Steady-state diffusion in a tokamak, 3:27525
Pardo, R.C., *See* Davids, C.N., 3:27355
Parilov, V.A., Analysis of pulverized fuel preparation systems equipped with different mills, for an 800 mw block fired by Kansk-Achinsk coal varieties, 3:25709
Paris, R., *See* Bagley, K.Q., 3:26307
Park, G.M., Oil potential of Mesozoic sediments beneath the Independence Mountain thrust fault, North Park, Colorado, 3:25731
Park, W., Numerical simulation of Padua Eta-Beta reverse-field pinch, 3:27526
Parker, D.L., *See* Whitmore, J., 3:27139
Parker, S.I., *See* Ballagh, H.C., 3:27114
See Scharre, D.L., 3:27113
Parkinson, W.W. Jr., Realistic calibration of whole body counters for measuring plutonium, 3:26817 (IAEA-SM—222/57)
Parks, L.A., *See* Davids, C.N., 3:27355
Paroder, S.Sh., *See* Feofilov, G.P., 3:25708
Parrish, D.K., Non-linear least-square fitting approach for determining activation energies for high temperature creep (abstract), 3:26110
Parrish, W.R., *See* Voth, R.O., 3:25957
Parry, R.F., *See* Cerny, J., 3:26803
Pascard, R., French advanced fuels development program, 3:26296
Pascaud, C., *See* Bogert, D., 3:27145
Passavy, J., *See* Avias, J., 3:26101
Passell, L., *See* Glinka, C.J., 3:26612
Patel, P.M., *See* Biswas, N.N., 3:27132
Patrascioiu, A., *See* Henyey, F.S., 3:27156
Patton, H.G., *See* Jones, W.A., 3:27671
Pau, J., *See* Attari, A., 3:25641
Paul, J.W.M., *See* Fielding, S.J., 3:27625
Paulikas, G.A., Aerospace Corporation space sciences program: report to COSPAR CY 1976. Interim report, 3:27026 (AD-A—043372)
Pavlov, G.G., Photon absorption and emission in Coulomb collisions in a magnetic field, 3:27529
Pavlova, G.L., *See* Shpak, V.S., 3:26361
Pavlyuk, V.F., *See* Burgvits, G.A., 3:26140
Pawlak, W., *See* Wachowska, H., 3:25672
Payne, M.G., *See* Hurst, G.S., 3:27062
Pazhitnova, N.P., *See* Gun, R.B., 3:25789
Peacock, K.L., Design of discrete nonadaptive operators for seismic data processing, 3:27010
Pearce, R.L., *See* Martin, C.W., 3:25768
Pearl, R.H., Use of geothermometer models in the exploration for a hydrogeothermal resource, 3:26097
Pearlstein, S., *See* Burrows, T.W., 3:27313
Pease, R.S., Summary of magnetic confinement (experiments), 3:27455
Peck, Biochemistry of methanogeness, 3:26026 (SRO—0888-2, pp 61-73)
Pecora, L.M., Carbon analysis in fly ash, 3:25685
Pecseli, H.L., *See* Dysthe, K.B., 3:27575
Pedersen, F., Choice of harmonic number for the ISABELLE accelerating rf system, 3:26807 (BNL—23535)
See Humphrey, J.W., 3:26804
Peebles, M.W.H., World LNG trade: present status and long term prospects, 3:25851
Peek, J.M., Continuum orbital approximations in weak-coupling theories for inelastic electron scattering, 3:27072
Pegg, D.J., Radiative lifetimes of the low-lying levels of Na-like copper, 3:27080
Pegoraro, F., *See* Coppi, B., 3:27555
Peisakhov, S.I., Experimental investigation of the displacement of uniform mixing nonnewtonian systems, 3:25758
Peletskii, V.E., Electrical resistance of niobium in the temperature range 200—2700°K, 3:26621
Pellegrin, J.L., *See* Allen, M.A., 3:26812
Pelletier, C.A., Long term performance of charcoal absorbers removing radioiodine in ventilation exhaust air. Final report, 3:26356 (EPRI-NP—534)
Pelletier, G., Analysis of the Dupree-Weinstock theory of a turbulent plasma in a magnetic field, 3:27503
Pellett, D.E., *See* Jonckheere, A.M., 3:27144
Peng, Y.K.M., ORNL TNS Program: plasma engineering considerations and innovations for a medium field tokamak fusion reactor, 3:27637 (ORNL/TM—6150)
Peng, Y.M., Magnetohydrodynamic equilibria and local stability of axisymmetric tokamak plasmas, 3:27437
Penndorf, K., Changes in pressurized water reactor group constants caused by burnup and the role of fuel nuclides, 3:26247
Pepin, H., *See* Grek, B., 3:27686
Peregudov, G.V., *See* Ilyukhin, A.A., 3:26749
Perkins, F.W., Heating tokamaks via the ion-cyclotron and ion-ion hybrid resonances, 3:27584
Perkins, R.A., *See* Hemmings, P.L., 3:25626
Perl, M.L., Comments on the tau heavy lepton, 3:27110 (SLAC-PUB—1991)
Evidence for, and properties of, the new charged heavy lepton, 3:27109 (SLAC-PUB—1923)
Evidence for, and properties of the tau lepton, 3:27112 (SLAC-PUB—2055)
Physics careers, employment and education (Penn State, 1977), 3:27425
See Scharre, D.L., 3:27113
Perlmutter, M., Three velocity component, nonhomogeneous atmospheric boundary-layer turbulence modeling, 3:27031
Perneczky, L., Breakdown transient phenomena at the fall-out of the primary circuit cooling pumps at Paks Nuclear Power Plant, 3:26474
Perona, M., *See* Lleres, J., 3:26286
Perry, B., *See* Yaakobi, B., 3:27474
Persse, F.H., Coal surface mining reclamation costs in the western United States. Information circular, 3:25686 (PB—269945)
Peruzzi, I., *See* Piccolo, M., 3:27103
See Scharre, D.L., 3:27113
Pesce, E., *See* Calza-Bini, A., 3:26302
Peter, E.A., *See* DeFrees, D.J., 3:26691
Peter, F.G., *See* Farfaletti-Casali, F., 3:27599
Peters, K.A., Determination of floor response spectra on the basis of the response spectrum method, 3:26449
Peters, M.W., *See* Ballagh, H.C., 3:27114
Peters, V.A., Offshore platform NDT instrumentation requirements, 3:25749
Peters, W.A., *See* Bush, T.W., 3:25619
Petersen, C.F., *See* Lambert, D.G., 3:26863
Peterson, F.C., *See* Leeper, R.J., 3:27143
Peterson, G.A., *See* Euteneuer, H., 3:27343
Peterson, R.E., *See* Lin, J.H., 3:26072
Peterson, R.J., Reappraisal of the $^{24}Mg(^{3}He,t)^{24}Al$ data to low-lying 1^{+} states, 3:27339
Peterson, V.Z., *See* Ballagh, H.C., 3:27114
Peterson, W.C., Dynamics of nucleate region flow boiling, 3:26348
Petrick, N.A., Progress report on the SNUPPS nuclear stations, 3:26240
Petrie, L.M., *See* Hoffman, T.J., 3:26283
Petrosyan, R.V., Potassium—sodium metasomatites of a hydrothermal, uranium—molybdenum ore deposit, 3:25906
Petrov, B.P., *See* Radchenko, E.D., 3:25771
Petrov, E.V., *See* Aizen, Kh.K., 3:26165
See Sotnikov, I.A., 3:26164
Petrov, S.I., *See* Kalafati, D.D., 3:26162
Petrovichev, V.I., *See* Korsun, A.S., 3:26404
Pettit, R.B., Laser ray trace and bi-directional reflectometry measurements of various solar concentrators, 3:26062 (SAND—77-1466C)
Petty, R.L., *See* Kerrisk, J.F., 3:26325
Petukhov, V.A., Experimental investigation of thermal expansion of a number of construction materials, niobium, and niobium alloy 5VMTs1, 3:26618
Experimental study of the thermal expansion of various construction materials. Tantalum and tantalum—tungsten TV—10 alloy, 3:26617
Pevsner, A., *See* Gilchriese, M.G.D., 3:27138
Pfeffer, J.T., Biological conversion of biomass to methane, 3:26018 (COO/2991—19, pp 111-118)
Pfeffer, R., *See* Lee, K.C., 3:25677
Pfeiffer, E., *See* Friedrich, G., 3:26460
Phaneuf, R.A., *See* Olson, R.E., 3:27076
Phelan, J.J., *See* Ward, C.E.W., 3:27142
Phelps, M.E., Investigation of ^{18}F-2-deoxyglucose for the measure of myocardial glucose metabolism, 3:26993 (UCLA—12-1142)
Phillion, D.W., Brillouin scatter in laser-produced plasmas, 3:27447
See Haas, R.A., 3:27448
Phillips, R.J.N., *See* Barger, V., 3:27188, 3:27189, 3:27195
Phillips, S.L., *See* Ozbek, H., 3:26114
Piar, G., *See* Godin, M., 3:26057
Piccolo, M., Inclusive baryon production in $e^{+}e^{-}$ annihilation, 3:27103
See Scharre, D.L., 3:27113
Pickering, G.A., *See* George, J.F., 3:25979
Piekut, D.T., *See* Knigge, K.M., 3:26983
Pieper, S.C., *See* Rehm, K.E., 3:27352
Piercey, R.B., *See* Ronningen, R.M., 3:27374
Pietilaeinen, E.P., Kinematical enhancements due to pion diffraction dissociation into K anti K* and K anti *K: Spinless treatment, 3:27223
Pietrzyk, Z.A., *See* Massey, R.S., 3:27568
Pikel'ni, V.F., *See* Abakumov, G.A., 3:26758
Piksaikin, V.M., Number and spectra of neutrons for specified fragments in spontaneous fission of ^{252}Cf, 3:27383
Piliposyan, S.E., *See* Abramyan, L.O., 3:27105
Pilloff, H.S., Explosively driven laser amplifier system, 3:26759
Pillow, N.W., *See* Smith, B.A., 3:26394
Pilloy, M., *See* Bonfiglioli, G., 3:25849
Pinajian, J.J., *See* Collins, W.E., 3:27371
Pinfold, D.R.M., Energy audits for industry, 3:26556
Pinkovskii, Ya.I., *See* Isaev, V.N., 3:25777
Pinkus, O., Strategy for energy conservation through tribology, 3:26706 (TID—28175)
Pipkin, F.M., *See* Bebek, C.J., 3:27104
Piron, C., Category of the CROCs and their interpretation, 3:27412

Pisacane, F.J., *See* Bowen, R.E., 3:26727
Pitt, W.W. Jr., ANFLOW treatment of municipal waste water, 3:26011 (COO/2991—19, pp 49-52)
Pittman, C.U. Jr, *See* Helbert, J.N., 3:26693
Pitts, D.E., *See* Heinken, G., 3:26089
Pitts, J.H., Gas flow in a permeable earth formation containing a crack, 3:26857
Piwinskii, A.J., *See* Dengler, L.A., 3:26119
Plaksin, O.T., *See* Shnitser, I.N., 3:26157
Plastinin, Yu.A., Experimental study of the optical absorption cross sections of nitrogen dioxide, 3:27059 (LA-tr—78-1)
Plisov, A.V., *See* Minsker, K.S., 3:25776
Plitz, H., GFEK experimental approach to carbide fuel element licensing, 3:26314
Ploszajczak, M., *See* Faessler, A., 3:27368
Ploum, A.J.W., Brunei liquefied natural gas plant, 3:25836
Pocock, R.F., Nuclear power. Its development in the United Kingdom, 3:26206
Pocrnja, A., Electricity generation by utilization of LNG-cold, 3:25839
Poddubnyi, B.N., *See* Krupenikov, V.V., 3:26182
Podgornov, V.M., *See* Angelopulo, O.K., 3:25757
Podgorochnyi, P.I., *See* Polynovskii, Ya.L., 3:26159
Poeppelmeier, K.R., *See* Corbett, J.D., 3:26677
Poggio, E.C., Calculations of the infrared behavior of quantum chromodynamics: The color-singlet quark form factor in the near-mass-shell regime, 3:27280
Is there a signal of quark confinement from perturbation theory, 3:27161
Near-mass-shell infrared behavior of non-Abelian gauge theories and the renormalization group, 3:27279
Pohl, B.A., *See* Booth, R., 3:26789
Pohlenz, J., Ultrastructure of cryptosporidia in the Bovine species, 3:26975 (CONF-770504—, pp 14-15)
Poindexter, E.H., *See* Helbert, J.N., 3:26693
Pokusaeva, L.V., *See* Varshaver, E.M., 3:25788
Polikanov, S.M., *See* Nedorezov, V.G., 3:27386
Politzer, H.D., More freedom now: an explanation of local duality and other mysteries, 3:27164
See Georgi, H., 3:27172
Pollitzer, E.L., *See* Hibbs, F.M., 3:25766
Polmear, I.J., Role of materials in energy production, 3:26593
Polo, A., *See* Bombi, F., 3:27693
Polonskii, V.S., *See* Styrikovich, M.A., 3:26707
Polyakov, G.A., *See* Burgvits, G.A., 3:26140
Polyakova, A.A., *See* Radchenko, E.D., 3:25771
Polynovskii, Ya.L., High pressure single-housing collector preheaters for the 800 MW power unit, 3:26159
Pomot, C., *See* Pelletier, G., 3:27503
Pondrom, L., *See* Heller, K., 3:27129
Ponomarev, G.S., Limits of existence of fluidized bed of solid particles in vessel with dual-flow grid, 3:25780
Ponti, C., *See* Burn, K., 3:27609
Pontius, P.E., Joint ANSI-INMM 8.1: Nuclear Regulatory Commission study of uranium hexafluoride cylinder material accountability bulk measurements, 3:25953 (RFP—2634)
Popalov, V.V., *See* Kalafati, D.D., 3:26177
Popel', O.S., Limiting values of the energy generated by pulsed MHD converters, 3:26536
Popescu, C., Fittings in energy engineering, 3:26368
Popov, I.A., *See* Buzankin, V.V., 3:27451
Popp, M., Energy research program of the Federal Republic of Germany, 3:26341
Poppe, C.H., *See* Fitzgerald, D.H., 3:27365
Popytaev, A.N., *See* Burtsev, V.A., 3:27460
Porch, W.M., Comparison of aerosol and momentum mixing in dust storms using fast-response instruments, 3:26866
Porter, F.C., *See* Ballagh, H.C., 3:27114
Porter, G.D., *See* Damm, C.C., 3:27531
Porter, R.B., *See* Boley, C.C., 3:25617
Post, D.E., *See* Jensen, R.V., 3:27627
Postol, T.A., *See* Chen, S.H., 3:26592
Pouzo, J., *See* Bruzzone, H., 3:27493
Povyshev, V.M., *See* Andreev, M.F., 3:27385
Powell, E.C., *See* Viles, J.M., 3:26982
Powell, K.F., *See* Miertschin, G.N., 3:26396
Powers, R.J., *See* Roberson, P., 3:27130
Pozdnyak, N.Z., Temperature dependence of the thermal conductivity and electrical conductivity of sintered molybdenum in the low-temperature region, 3:26623
Pratap, M., *See* Raja, R., 3:27128
See Whitmore, J., 3:27139
Prater, R., Observation of the dissipative trapped electron instability in toroidal geometry, 3:27543
Pratt, J.C., *See* Gram, P.A.M., 3:27058
Pregler, R., Resonaflex, the anticorrosive multi-purpose plate for thermal and acoustic insulation, 3:26584
Prelec, K., *See* Sluyters, T., 3:26800
Prentice, R., *See* Fielding, S.J., 3:27625
Preston, R.C., Spectral-line-blending calculations applied to highly excited atomic levels in high-density argon plasmas, 3:27516
Prettie, C., Project STRESS satellite communication test results. Final technical report, June 1976—March 1977, 3:27041 (AD-A—043873)
Prew, L.R., *See* Findlater, A.E., 3:25874
Price, D.R., *See* Jewell, W.J., 3:26010
Price, H.L., *See* Whitmore, J., 3:27139
Primakoff, H., *See* Goulard, B., 3:27326
Prindle, A.L., *See* Nethaway, D.R., 3:27381
Prior, R.L., *See* Hashimoto, A.G., 3:26017
Prior, W., *See* Bostick, W.H., 3:27483
Pritchett, P.L., Phase mixing in the continuous spectrum of Alfven waves, 3:27572
Proctor, S.J., *See* Barnett, D., 3:26981
Pronko, P.P., Direct observation of self-interstitial-type defects in metals through combined single-double alignment channeling backscattering, 3:26627
Proshin, S.V., *See* Il'lna, I.L., 3:27402
Prosser, F.W. Jr., *See* Geesaman, D.F., 3:27350
See Tabor, S.L., 3:27340
Protopopescu, S.D., New states below 2.2 GeV observed in $e^+ e^-$ annihilations, 3:27136 (BNL—23612)
Pruess, K., *See* Baltz, A.J., 3:27369
Pruneau, P.N., *See* Delorey, D.E., 3:27034
Pryanikov, E.I., *See* Rustamov, M.I., 3:25774
Przydrozny, M., *See* Montet, A., 3:25873
Pugach, L.I., *See* Levit, G.T., 3:26169
Pugmire, R.J., *See* Franz, J.A., 3:25669
Pun, T.P., *See* Scharre, D.L., 3:27113
Purvis, G., Koeberg's cooling water marine basin next on agenda, 3:26241
Puttagunta, V.R., Role for nuclear energy in the recovery of oil from the tar sands of Alberta, 3:25894
Putvinskii, S.V., Neutrals escape on a wall due to charge exchange while neutral beam injection into a toroidal plasma, 3:27429 (IAE—2520)
Putzrath, R.M., Characterization of an enveloped mycoplasmavirus, 3:26977 (UR—3490/LCP-4)
Pyatak, A.I., *See* Mikhajlovskii, A.B., 3:27563
Pyatak, A.N., *See* Mikhajlovskii, A.B., 3:27564
Pyatnitskii, L.N., *See* Batenin, V.M., 3:27475
Pyle, R.V., *See* Berkner, K.H., 3:27658

Q

Quapp, W.J., *See* MacDonald, P.E., 3:26443
Quimby, D.C., *See* Krakowski, R.A., 3:27454
Quinlivan, W.D., Chemical data and variation diagrams of igneous rocks from the Timber Mountain-Oasis Valley, Caldera Complex, southern Nevada, 3:27018 (USGS-OFR—77-724)
Quinn, W.E., *See* Cantrell, E.L., 3:27583

R

Rabinovich, M.I., *See* Vyshkind, S.Ya., 3:27587
Rabinovici, E., *See* Eylon, Y., 3:27283
Rabinowtiz, M., *See* Martin, N.C., 3:26950
Raczka, R., *See* Balaban, T., 3:27308
See Maurin, K., 3:27419
Radchenko, E.D., Influence of feedstock distillation range on hydrocarbon conversion and changes in luminometer number upon dearomatization of distillates from Nizhnevartovsk crude oil, 3:25771
Radecky, G.M., *See* Barish, S.J., 3:27116
Radovskii, I.S., Propagation speeds for perturbations in a flow of a two-phase mixture, 3:26774
Rager, J.P., *See* Maisonnier, C., 3:27496
Ragozin, A.A., Dynamic stability of hydraulic generators operating under the conditions of consumption of reactive capacity, 3:25981
Ragozin, E.N., *See* Ilyukhin, A.A., 3:26749
Rai, C., *See* Ishimasa, Y., 3:25886
Rai-Choudhury, P., *See* Hopkins, R.H., 3:25990
Raich, D., *See* Smither, R.K., 3:27364
Rainer, F., *See* Haas, R.A., 3:27448
Raither, S.W., *See* Bebek, C.J., 3:27104
Raj, P.P.K., Development of additional hazard assessment models. Final technical report, 3:26929 (AD-A—042365)
Raja, R., Inclusive rho^0 and f^0 production in 100-GeV/c p anti p interactions, 3:27128
Rajagopalan, M., *See* Miller, J.M., 3:27379
Ram Chandra, *See* Verma, J.S., 3:27488
Ramayya, A.V., *See* Cole, J.D., 3:27370
See Ronningen, R.M., 3:27373, 3:27374
Ramirez, J.J., Pulsed power applications to intense neutron source development, 3:26793
Ramsey, W.J., Energy and Resource Planning Group FY 1977 annual report, 3:26495 (UCRL—50029-77)
Ramshaw, J.D., Numerical method for two-dimensional steady-state chemical laser calculations, 3:26765
Ranade, M.B., Study of aerosol assessment instrumentation. Final report Jun—Oct 76, 3:26869 (AD-A—046052)
Randall, C.M., *See* Dowling, J.M., 3:26636
Randolph, P.L., Natural gas content of geopressured aquifers, 3:25826 (CONF-771153—1)
Rangan, L.K., *See* Whitmore, J., 3:27139

Rankin, W.N., Compatibility testing of vitrified waste forms, 3:25936 (DP-MS—77-115)
Rao, P.V., *See* Palms, J.M., 3:27056
Rapidis, P.A., *See* Scharre, D.L., 3:27113
Rappaport, S.M., *See* Morales, R., 3:26997
Raskin, A.Ya., *See* Egerev, V.V., 3:25972
Rasmuson, D.M., *See* Burdick, G.R., 3:26221
Rasmussen, J.W., *See* Roepke, W.W., 3:25701
Rasmussen, N.C., How safe is nuclear power, 3:26451
Rassokhin, N.G., Critical conditions with unsteady-state outflow of a two-phase medium with a pipeline break, 3:26773
Ratcliff, B.N., *See* Gilchriese, M.G.D., 3:27138
Rautista, R.G., *See* O'Brien, W.G., 3:26671
Rawlings, J.C., *See* Brayman, K.W.
George, D.K., 3:26398
Ray, W. Jr., *See* Elwyn, A.J., 3:27337
Realini, G., *See* Burn, K., 3:27609
Rebuck, N.D., *See* Conte, A.A. Jr, 3:26690
Rechester, A.B., Electron heat transport in a tokamak with destroyed magnetic surfaces, 3:27443
Redding, G.B., Method for the fabrication of a fuel body from an agglomerate of fuel particles, 3:26397
Redford, D.A., *See* Cram, P.J., 3:25896
Redish, E.F., *See* Tandy, P.C., 3:27394
Redwine, R.P., *See* Bowles, T., 3:27334
See Fisher, T.R., 3:27375
Reed, W.E., Electric power load management (citations from the NTIS data base). Report for 1964—July 1977, 3:26197 (NTIS/PS—77/0690)
Reeves, J., *See* Bartlett, D.F., 3:27258
Regge, T., *See* Broglia, R.A., 3:27096
Rehm, K.E., Inelastic scattering of ^{16}O on even-Ca isotopes, 3:27352 (ANL—77-60, pp 50-52)
See Geesaman, D.F., 3:27350
See Jackson, H.E., 3:27323
See Meyer-Schuetzmeister, L., 3:27347
See Tabor, S.L., 3:27340
Reibel, K., *See* Lindquist, J., 3:27117
Reichmuth, H.S., Design and analysis of a cow manure heat exchanger for the 100,000 gallon methane-producing digester in Monroe, Washington, 3:26014 (COO/2991—19, pp 63-76)
Reid, I., Marine engineering--the canadian challenge, 3:26124
Reid, M.S., Precision insolation measurement under field conditions, 3:25984
Reihlen, H., Standardization in nuclear engineering, 3:26342
Rein, J.E., *See* Marsh, S.F., 3:26665
Reisacher, R., Boiler, 3:26246
Remiddi, E., Status of the analytic calculations of QED sixth order radiative corrections to the electron anomaly, 3:27294
Remmers, G., Protection of lead accumulators against low discharge, 3:26493
Rennie, C.A., Reactor core consisting of a number of interspersed groups of identical columns, 3:26266
REPPY, J., *See* BURNHAM, J., 3:27095
Rescigno, T.N., Comments on the existence of low-energy d-wave resonances in electron-fluorine atom scattering, 3:27073
Photoabsorption in molecular nitrogen: A moment analysis of discrete-basis-set calculations in the static-exchange approximation, 3:27084
See Hazi, A.U., 3:27050
Rest, J., *See* Ward, C.E.W., 3:27142
Reveillard, Y., *See* Bellus, F., 3:25888
Rex, D., Solar cell equipment with concentrating mirrors and radiator surfaces, 3:25997
Reynolds, P., *See* Challender, R.S., 3:27593
Reznik, S.N., *See* Kolesnichenko, Ya.I., 3:27550
Rhines, D.S., *See* Biswas, N.N., 3:27132
Ribe, F.L., *See* Bartsch, R.R., 3:27540
Riccardella, P.C., Boiling Water Reactor feedwater nozzle/sparger interim program report. Supplement No. 2: fracture mechanic analysis of JAERI model pressure vessel test, 3:26437 (NEDO—21480-02)
Richter, B., Production of new particles and muon-electron events in e^+-e^- annihilation at spear, 3:27100 (SLAC-PUB—1737)
Richter, G., *See* Burkhardt, W., 3:26376
Rickard, W.H., Abiotic components, 3:25945 (PNL—2253, pp 2.1-2.5)
See Rogers, L.E., 3:25943
See Uresk, D.W., 3:25946
Riddiford, C.L., *See* Driver, P.M., 3:26064
Riedinger, L.L., *See* Cole, J.D., 3:27370
See Ronningen, R.M., 3:27373, 3:27374
Riesenfeld, W., *See* Cantrell, E.L., 3:27583
Rigg, S., *See* Ashcroft, D.J., 3:26225
Rioux, C., Energetic aspects of fast-fusion reactors with dense liners of medium velocities (10 to 100 kms^{-1}), 3:27704
Ripin, B.H., *See* Decoste, R., 3:27442, 3:27669
Risebrough, R.W., *See* White, C.M., 3:26906
Ritson, D.M., psi and excess leptons in photoproduction, 3:27099 (SLAC-PUB—1728)
Rivier, M., Finite element computation of plasma equilibria, 3:27502 (COO—2456-52)
Rizk, H.M., Toroidal MHD stability in complex magnetic configurations, 3:27515
Rizzo, T., *See* Mathur, V.S., 3:27192
Roach, F., Prospects for solar energy: the impact of the National Energy Plan, 3:25985 (LA—7064-MS)
See Ben-David, S., 3:26051
Robb, R.A., *See* Bowen, R.E., 3:26727
Robb, W.D., Close-coupling calculations of electron scattering by atomic fluorine, 3:27074
Roberson, P., Strong interaction and mass measurements using antiprotonic atoms, 3:27130
Robertson, G.W.E., Passivation and corrosion, 3:26785
Robertson, R.F.S., *See* Puttagunta, V.R., 3:25894
Robertson, W.J., *See* Biswas, N.N., 3:27132
Robin, A.M., Gasification of residual materials from coal liquefaction. Evaluation of SRC II vacuum flash drum bottoms as feedstock to the Texaco Coal Gasification Process, 3:25632 (FE—2247-9R)
Robinson, B., *See* Jonckheere, A.M., 3:27144
Robinson, D.C., *See* Dibiase, J.A., 3:27560
Robinson, D.L., Ultrasonic wave generator, 3:26377
Robinson, G., *See* Phelps, M.E., 3:26993
Robinson, R.L., High-spin states in ^{70}Ge, 3:27358
See Ronningen, R.M., 3:27373
See Wells, J.C. Jr., 3:27357
Robinson, S.L., Hydrogen compatibility of structural materials for energy storage and transmission applications. Semiannual report, April 1, 1977—October 1, 1977, 3:25962 (SAND—77-8296)
Robson, A.E., *See* Book, D.L., 3:27600
Rocca, U.V., *See* Calza-Bini, A., 3:26302
Rocek, M., *See* Das, A., 3:27257
Roche, M., *See* Hourst, J.B., 3:26792
Rodabaugh, E.C., Evaluations of the piping system inelastic analysis computer program PIRAX2, 3:26276 (AI-DOE—13216)
Rodon, I., *See* Lee, K.C., 3:25677
Roe, J.M., Integrated circuit electromagnetic susceptibility investigation. phase III. Summary report No. 2, 3:26834 (AD-A—043776)
Integrated circuit electromagnetic susceptibility investigation. Phase III. IC susceptibility handbook-draft 2, 3:26835 (AD-A—043777)
Roeder, D.L., *See* McCarthy, J., 3:27320
Roehrdanz, K., Nuclear engineering, 3:26343
Roensch, F.R., *See* Marsh, S.F., 3:26665
Roepke, W.W., Linear cutting rotary head continuous mining machine, 3:25701
Method of operating a constant depth linear cutting head on a retrofitted continuous mining machine, 3:25700
Roeske, F. Jr., Superconducting- and normal-state thermal conductivity of $NbSe_2$, 3:26654
Roesler, F.L., *See* Fonck, R.J., 3:27048
Rogan, F.H., *See* Li, K., 3:25681
Rogers, L.E., Ecology of the 200 Area plateau waste management environs: a status report, 3:25943 (PNL—2253)
Energy flow and mineral cycling mechanisms, 3:25947 (PNL—2253, pp 4.1-4.10)
Future research needs, 3:25952 (PNL—2253, pp 9.1-9.17)
See Paine, D., 3:25949
See Uresk, D.W., 3:25946
See Uresk, V.A., 3:25944
Rogov, S.P., *See* Radchenko, E.D., 3:25771
Rogov, V.I., *See* Andreev, V.N., 3:27384
Romanov, V.A., Formation of deposits of poorly soluble corrosion products, 3:26160
Romanovskaya, N.S., *See* Omes, S.P., 3:25830
Romanowski, T.A., *See* Lindquist, J., 3:27117
Romanyuk, L.I., *See* Lisitchenko, V.V., 3:27586
Rome, J.A., *See* Goldston, R.J., 3:27592
See Northrop, T.G., 3:27508
See Peng, Y.K.M., 3:27637
Romero, L.L., *See* Vasilik, D.G., 3:26888
Romney, E.M., Estimated inventory of plutonium and uranium radionuclides for vegetation in aged fallout areas, 3:26913 (NVO—171, pp 35-119)
Ronan, M.T., *See* Scharre, D.L., 3:27113
Ronchi, C., *See* Matzke, H., 3:26634
Ronningen, R.M., Coulomb excitation measurements of reduced E2 and E4 transition matrix elements in $^{156-158}Dy$, $^{162-164}Er$, and ^{168}Yb, 3:27374
E2 and E4 reduced matrix elements of $^{154-156-158-160}Gd$ and $^{176-178-180}Hf$, 3:27373
See Robinson, R.L., 3:27358
See Wells, J.C. Jr., 3:27357
Roop, R.D., Energy from biomass: an overview of environmental aspects, 3:26004 (CONF-780109—3)
Rosa, L.P., *See* Ferreira, E.M., 3:27230
Rose, D., U.S. advanced fuels safety program, 3:26312
Rose, P.H., *See* Krakowski, R.A., 3:27454
Rosen, J., *See* Chaney, D., 3:27121
See Mollet, W., 3:27123
Rosen, M., *See* Mueller, G.P., 3:27399
Rosen, S.P., *See* Fischbach, E., 3:27200
Rosenbluth, M.N., Mode crossing in a Lagrangian system, 3:27090
Summary of magnetic confinement (theory), 3:27456
See Aamodt, R.E., 3:27548
See Rechester, A.B., 3:27443
See White, R.B., 3:27644
Rosenmann, M., *See* Morrison, P.R., 3:26970
Rosenson, L., *See* Humphrey, J.W., 3:26806
Ross, R.R., *See* Scharre, D.L., 3:27113
Roth, I., *See* Gell, Y., 3:27576

Rothchild, R.D., Longwall ignition suppression. Final report, 3:25694 (PB—270696)
Rothe, K.W., Remote sensing using tunable lasers, 3:26870 (AED-Conf—77-165-002)
Rothhaas, H., *See* Euteneuer, H., 3:27343
Rotoloni, P.L., *See* Calza-Bini, A., 3:26302
Rotty, R.M., Energy and the climate, 3:26868 (ORAU/IEA(M)—75-3)
Rozanov, V.B., *See* Afanas'ev, Yu.V., 3:27690
Rozovskii, A.Ya., Mechanism of methanol synthesis from carbon dioxide and hydrogen. III. Determination of rates of individual stages using ^{14}CO, 3:25967
Ruchti, R., *See* Chaney, D., 3:27121
See Mollet, W., 3:27123
Ruck, G.W., *See* Yang, T.F., 3:27621
Rudenko, I.m., Air preheater made of corrugated tubes, 3:26168
Rudnicka, H., *See* Ballagh, H.C., 3:27114
Rudnik, A.G., *See* Lokhmatikov, G.P., 3:25980
Rudolph, H., *See* Zimmerman, W.R., 3:27349
Rudolph, P.F.H., Art of coal gasificaion, 3:25646
Rudy, T.E., *See* Crowley, W.P., 3:26770
Rudyak, B.V., *See* Zakhar'ev, B.N., 3:27311
Ruehl, W., *See* Kupsch, J., 3:27304
Ruiz, N.K., *See* Thompson, S.L., 3:27706
Rumyantseva, E.S, *See* Mukhlenov, I.P., 3:26668
Ruo, T., *See* Selucky, M.L., 3:25900
Rupasov, A.A., *See* Basov, N.G., 3:27689
Rupert, V.C., *See* Haas, R.A., 3:27448
See Phillion, D.W., 3:27447
Rusakov, M.M., Features of the expansion of condensed substances acted on by high-power shock waves, 3:26613
Rushbrooke, J.G., *See* Raja, R., 3:27128
Rushton, A.M., *See* Roberson, P., 3:27130
Russell, E.S., Inborn anemias in mice. Progress report, 1 May 1976—31 July 1977, 3:26987 (COO—3264-16)
Russell, J.L. Jr., Principles of fixed mirror solar concentrator, 3:26077
Russell, O.R., Application of Landsat-2 data to the implementation and enforcement of the Pennsylvania Surface Mining Conservation and Reclamation Act. Final report, March 1975—May 1977, 3:26921 (E—77-10184)
Rust, D.R., *See* Ward, C.E.W., 3:27142
Rustamov, M.I., Effect of catalytic cracking method in product yields, 3:25774
Rutledge, L.L. Jr., *See* Bowles, T., 3:27334
See Jackson, H.E., 3:27323
Rutledge, L.R. Jr., *See* Tonn, J.F., 3:27345
Rynes, P., *See* Miller, D., 3:27131
Ryskin, M.G., *See* Levin, E.M., 3:27210
Ryutov, D.D., *See* Vekshtejn, G.E., 3:27458

S

Saboe, E.P., *See* Kleinstein, B.H., 3:27000
Sachs, P.L., *See* Spencer, D.W., 3:26930
Sadnicki, M., *See* Sassin, W., 3:25721
Saff, E.B., Geometric overconvergence of rational functions in unbounded domains, 3:27716
Nonuniqueness of best approximating complex rational functions, 3:27714
Sage, W.L., Characteristics of solvent refined coal: dual register burner tests. Final report, 3:25711 (EPRI-FP—628)
Sahevskii, V.V., *See* Gladkikh, V.A., 3:25816
Saito, H., Approximate theory of steady-state and dynamic characteristics of alpha-particle-heated DT-fusion reactors, 3:27462
Dynamic characteristics of alpha-particle heating based upon the Fokker-Planck equation in D-T fusion reactor core plasmas, 3:27457
Saito, M., Isomerization of n-pentane on group VIII metal/hydrogen-zeolite Y catalysts, 3:25783
Saksagansky, G.L., *See* Odintsov, V.N., 3:27700
Sal'nikov, O.A., *See* Biryukov, N.S., 3:27354
Salem, S.L., New methodology for the computer-aided construction of fault trees, 3:26472
Salomov, D.A., *See* Bannik, B.P., 3:27118
Salop, A., *See* Olson, R.E., 3:27076
Saltanov, G.A., *See* Deich, M.E., 3:26772
Saltmarsh, M.J., Characteristics of an intense neutron source based on the d+Be reaction, 3:26794
Salvador, L.A., *See* Keairns, D.L., 3:25628
Salzano, F.J., *See* Batey, J., 3:26777
Salzman, G.C., *See* Bartholdi, M., 3:26823
See Mullaney, P.F., 3:26961
Samoilenko, Yu.I., *See* Dargeiko, M.M., 3:27498
Samuel, M.A., *See* Chlouber, C., 3:27173
Sanborn, A.F., Possible future petroleum of Uinta and Piceance basins and vicinity: northeast Utah and northwest Colorado, 3:25726
Sanders, J.P., *See* Ball, S.J., 3:26255
Sandler, B., *See* Miller, D., 3:27131
Sandstrom, W.A., Modification and operation of the atmospheric ash-agglomerating gasifier on coal. Project 9020 monthly progress report, October 1977, 3:25634 (FE—2336-17)
Sangalov, Yu.A., *See* Minsker, K.S., 3:25776
Sangiovanni, J.J., Theoretical and experimental investigation of the ignition of fuel droplets, 3:26702
Sarisyan, D.G., *See* Gyuzalyan, R.N., 3:26756
Sashina, E.K., *See* Krainov, V.N., 3:25971
Sasser, D.W., *See* Chapman, L.D., 3:25954
Sassin, W., Medium-term aspects of a coal revival: two case studies, 3:25721 (IIASA-CP—77-5)
Sasso, J.R., *See* Sherwood, G.G., 3:26217
Sastry, K.S.R., *See* Cole, J.D., 3:27370
Satani, M., *See* Tanaka, S., 3:25867
Sato, K.N., High-temperature high-quality deuterium plasma production by laser beam(s) by means of on-line computer control technique, 3:27427 (EUR—5602, pp 879-884)
Sato, O., Neutron radiography experiments at JRR-4, (2). Neutron radiography of simulated mixed-oxide fuels, 3:26390
Sauer, R., Management models, 3:25950 (PNL—2253, pp 7.1-7.15)
Saunders, B.B., Reactions of thiophene with radiolytically produced radicals. I. The hydroxyl radical, 3:26695
Reactions of thiophene with radiolytically produced radicals. II. The solvated electron and the hydrogen atom, 3:26696
Saunders, G.G., *See* Dolby, R.E., 3:26359
Sauthoff, N.R., Study of disruptive instabilities in the PLT Tokamak using x-ray techniques, 3:27469 (PPPL—1379)
Savin, V.I., Problems of improving the methods of designing heat supply systems, 3:26545
Savino, J.M., *See* Lambert, D.G., 3:26863, 3:26865
Savor, D.E., Process and arrangements for removing a tube from a tube plate, 3:26379
Savushkin, A.F., *See* Birman, A.Y., 3:26747
Savushkina, V.A., *See* Nitikin, A.K., 3:25965
Savy, K.R., *See* Tsybulevskii, A.M., 3:25773
Savvov, R.V., *See* Gus'kov, Y.K., 3:27081
Saxena, S.C., *See* Chen, T., 3:25717
Sayer, R.O., *See* Peng, Y.M., 3:27437
See Robinson, R.L., 3:27358
See Wells, J.C. Jr., 3:27357
Saylor, T.K., *See* Cocke, C.L., 3:27070
Scailteur, A., *See* Martin, A., 3:26238
Schabert, H.P., Pressurized-water reactor, 3:26253
Schachinger, L., *See* Heller, K., 3:27129
Schacht, P., *See* Gilchriese, M.G.D., 3:27138
Schaefer, J., *See* Bartuska, V.J., 3:25668
Schaefer, K., Licensing procedures according to the Federal Act for Protection Against Nuisances. Text of the 9th implementation ordinance with explanations and supplementing regulations, 3:26892
Schaeffer, D.A., *See* Herley, P.J., 3:26697
Schalk, T., *See* del Papa, C., 3:27102
Scharbach, P.N., *See* Humpert, B., 3:27193
Scharre, D.L., Observation of D^0-meson decay into $K^-\pi^+\pi^0$, 3:27113
Schaude, G.R., Scenarios chemical technology, 3:26555 (BMFT-FB-T—77-01)
Schechter, B.M., Yang-Mills theory on the hypertorus, 3:27267
Schechter, H.S., Energy deposition rates and Compton electron currents from low-altitude bursts as a function of source energy. Interim report 17 Nov 76—1 Nov 77, 3:27042 (AD-A—046092)
Schechter, R.S., *See* Galichon, P., 3:25914
Schectman, R.M., *See* Hight, R.D., 3:27075
Scheer, H., Peripheral metal complexes: chlorophyll "isomers" with magnesium bound to the ring E β-keto ester system, 3:26674
Scheetz, E.J., Westinghouse seeks minimum costs with maximum reliability, 3:26242
Scheid, J., *See* Gilchriese, M.G.D., 3:27138
Schelbert, H.R., *See* Phelps, M.E., 3:26993
Scherrer, P.H., *See* Duvall, T.L. Jr, 3:27025
Schiefelbein, G.F., Alternative electrical transmission systems and their environmental impact, 3:26200 (PB—271652)
Schiffer, J.P., *See* Geesaman, D.F., 3:27350
See Jackson, H.E., 3:27323, 3:27359
Schimmel, W.P. Jr., *See* Lee, D.O., 3:26068
Schlemm, F., *See* Kaast, H., 3:25832
Schlueter, H., *See* Seifert, W., 3:26365
Schmidt, I.A., Relativistic interactions in nuclei and the approach to scaling in deep inelastic scattering, 3:27390 (SLAC—203)
Schmidt, P., *See* Briefel, E., 3:27140
Schmidt-Ott, W.D., *See* Cole, J.D., 3:27370
Schmincke, H.U., *See* Flower, M.F.J., 3:27009
Schmitten, W., *See* Hackstein, K., 3:26264
Schmitter, K.H., Summary of reactor systems, 3:27603
Schmitz, D., *See* Peters, K.A., 3:26449
Schnack, D., *See* Dibiase, J.A., 3:27560
Schneeberger, J.P., *See* Tai, A.S., 3:26355
Schneider, G., Rod-shaped fuel element for nuclear reactors, 3:26391
Schneider, M.J., *See* Zimmerman, W.R., 3:27349
Schneider, T., *See* Bruce, A.D., 3:26638
Schneps, J., *See* Briefel, E., 3:27140
Schnetzer, S., *See* Nagamiya, S., 3:27332
Schnitzer, H.J., *See* Abbott, L.F., 3:27243, 3:27244
Scholz, M., Nuclear reactor, 3:26478
See Hagen, H.G., 3:26369
Schonfelder, M., *See* Krug, H., 3:26965
Schoonover, M.R., *See* Hamlin, D.A., 3:27039, 3:27040

Schora, F.C., Low-Btu gas as an industrial energy source, 3:25625 (CONF-7710116—1)
Search for a new coal technology, 3:25622 (CONF-770814—12)
Schorr, J.R., Source assessment: pressed and blown glass manufacturing plants. Final task report Sep 75—Jan 77, 3:26882 (PB—273788)
Schott, J., *See* Costeseque, P., 3:26122
Schott, J.R., Aquatic and terrestrial surveys in the vicinity of power plants using remote sensing. Final report, 3:26920 (PB—273463)
Schott, L., *See* Chen, T., 3:27574
Schreckhise, R.G., *See* Paine, D., 3:25951
See Sauer, R., 3:25950
Schreiber, J.D., *See* Dafler, J.R., 3:25960
Schreiner, F., *See* Osborne, D.W., 3:26649
Schreiner, P., *See* Barish, S.J., 3:27116
See Derrick, M., 3:27125
Schreyer, H.L., Impulse attenuation of waves emanating from a cylindrical cavity in anisotropic media, 3:27415
Schubert, J.F., Acoustic detection of momentum transfer during the abrupt transition from a laminar to a turbulent atmospheric boundary layer', 3:26867
Schuengel, P., Stud tensioner for opening and closing the head of a reactor pressure vessel, 3:26375
Schult, F., *See* Penndorf, K., 3:26247
Schulte, H., *See* Schuengel, P., 3:26375
Schultz, P.F., *See* Barish, S.J., 3:27116
See Derrick, M., 3:27125
Schulz, P.A., *See* Grant, E.R., 3:27047
See Sudbo, A.S., 3:27046
Schulze, W., *See* Ben-David, S., 3:26051
See Roach, F., 3:25985
Schumacher, B.J., *See* Booth, R., 3:26789
Schuss, J.J., Measurements of the parametric decay of CO_2-laser radiation into plasma waves at quarter-critical density using ruby-laser Thomson scattering, 3:27440
Schuster-Wolff, A., *See* Schaude, G.R., 3:26555
Schwartz, A.S., Method for the coating of particles with single layers of pyrolytic carbon having different densities, 3:26269
Schwartz, D.M., *See* Lindquist, J., 3:27117
Schwarz, H., Procedure for purifying a filter column, 3:25929
Schwarzer, W., *See* Reihlen, H., 3:26342
Schweitzer, N., *See* Schwob, J.L., 3:27490
Schwentker, O., *See* Euteneuer, H., 3:27343
Schwier, K., *See* Haddenhorst, H.G., 3:25887
Schwitters, R., Recent results on new particle production at SPEAR, 3:27137 (SLAC-PUB—1998)
Schwob, J.L., Identification of Mo XV to Mo XXXIII in the soft X-ray spectrum of the TFR Tokamak, 3:27490 (EUR-CEA-FC—887)
Sciulli, F., *See* Barish, B.C., 3:27115
Scolnick, M.E., Methods of identifying source of petroleum found in the marine environment. Report II. Final report 26 Jun 72—17 May 76, 3:25800 (AD-A—046256)
Scotland, W.A., NEB veiw of development potential and markets for heavy crude oil, 3:25814
Scott, A.C., *See* Scolnick, M.E., 3:25800
Scott, D.W., *See* Miller, A., 3:27414
Scott, P.B., *See* Sze, R.C., 3:26737
Scott, W.H. Jr., *See* McDaniel, P.J., 3:26358
Scott-Monck, J., High efficiency solar panel (HESP). Final report, 1 June 1975—15 June 1977, 3:25987 (AD-A—043382)
Scudder, D.W., *See* Massey, R.S., 3:27568
Seamons, M., *See* Vasilik, D.G., 3:26888
Searcy, A.W., Kinetics of endothermic decomposition reactions. II. Effects of the solid and gaseous products, 3:26672
Sears, R.D., Ionospheric irregularities: optical support of HAES scintillation experiments. Final report, 15 December 1975—31 January 1977, 3:27038 (AD-A—043666)
Seay, J.G., World LNG trade and the competitiveness of present and projected prices, 3:25856
Sechi-Zorn, B., *See* Whitmore, J., 3:27139
Sedrakyan, A.G., *See* Asatryan, G.M., 3:27239
Seebaugh, W.R., Dynamic crater ejecta model. Final report, 1 October 1975—30 September 1976, 3:26855 (AD-A—042546)
Seed, T.J., TRIDENT: a new triangular mesh discrete ordinates code, 3:27616 (LA-UR—77-2511)
Seely, J.F., *See* Dixon, R.H., 3:27533
Segal, I., Constructive approach to nonlinear quantum field theory, 3:27307
Segel, R.E., *See* Bowles, T., 3:27334
See Jackson, H.E., 3:27323
See Tonn, J.F., 3:27345
Seger, G., *See* Bartholdi, M., 3:26823
Seiden, A., *See* del Papa, C., 3:27102
Seidl, A.A., *See* Lys, J.E.A., 3:27126
Seidman, D.N., *See* Wei, C.Y., 3:27055
Seifert, W., Guiding device for a manipulator mast for internal inspection of a reactor pressure vessel, 3:26365
Seiger, H., Ultrasonic inspection of the spherically shaped perforated areas of light water reactor pressure vessels, 3:26214
Seki, Y., Absolute fission-rate distributions in lithium and hybrid fusion blanket assemblies, (2). Analysis and evaluation, 3:27622
Sekiguchi, T., *See* Saito, H., 3:27457, 3:27462
See Sato, K.N., 3:27427
Sekito, N., *See* Murata, Y., 3:25868
Selig, H., *See* Osborne, D.W., 3:26649
Seliger, H.H., Chemical production of excited states: adventitious biological chemiluminescence of carcinogenic polycyclic aromatic hydrocarbons, 3:26946 (COO—3277-44)
Selin, C., *See* Phelps, M.E., 3:26993
Selin, K.I., *See* Bertolini, E., 3:27646
Selkirk, J.K., Comparative metabolism of benzo(a)pyrene in rodent liver and embryonic cells in tissue culture, 3:26995 (CONF-771147—2)
Sella, J., *See* Rassokhin, N.G., 3:26773
Selucky, M.L., Chemical composition of athabasca bitumen, 3:25900
Selvage, C., Optics in solar energy utilization II , 3:25983
Semenov, E.P., *See* Zakharov, A.S., 3:26750
Semenov, I.B., *See* Buzankin, V.V., 3:27451
Semenov, V.P., *See* Egerev, V.V., 3:25972
Semenyuk, V.M., *See* Burgvits, G.A., 3:26140
Senashenko, V.S., *See* Mishchenko, T.V., 3:27083
Senjanovic, P., *See* Halpern, M.B., 3:27274
Sepaniak, M.J., Laser two-proton excited fluorometric detection for high pressure liquid chromatography, 3:26837 (IS-T—792)
Serant, F.A., *See* Levit, G.T., 3:26169
Serebrennikov, D.V., *See* Odintsov, V.N., 3:27700
Sergein, E.P., *See* Gladkikh, V.A., 3:25816
Sergienko, S.I., Effect of thermal field on oil—gas formation in mesozoic deposits of the Western Siberian plate, 3:25728
See Matvienko, V.N., 3:26107
Serikov, A.V., *See* Dushin, L.A., 3:27590
Sermet, P., *See* Geller, R., 3:27652
Serov, V.I., *See* Andreev, M.F., 3:27385
Serykh, G.M., *See* Pozdnyak, N.Z., 3:26623
Seth, K.K., *See* Iversen, S., 3:27335
Sevnitskaya, N.I., *See* Ol'kov, P.L., 3:25769
Seward, F.D., *See* Zarnecki, J.C., 3:27030
Seyer, F.A., *See* Vossoughi, S., 3:25752
Seymour, A.H., Radionuclides in air, water, and biota, 3:26934 (TID—26712, pp 579-613)
Sha, W.T., Bubble dynamics in a superheated liquid, 3:26277 (ANL—77-20)
Shabalina, L.N., *See* Gun, R.B., 3:25789
Shagalova, S.L., *See* Shnitser, I.N., 3:26157
Shah, V.L., *See* Sha, W.T., 3:26277
Shaidullin, B.K., *See* Rusakov, M.M., 3:26613
Shaked, H., Sublattice magnetization in TbD_2: crystalline electric field effects, 3:26637
Shakhbazyan, V.A., *See* Grigoryan, L.A., 3:27235
Shakhsuvarov, K.L.V., Effect of temperature pulsations of the lower radiant section tubes on their service life, 3:26171
Shamraev, B.N., *See* Elesin, V.F., 3:27405
Shanks, H.R., *See* Roeske, F. Jr., 3:26654
Shanks, W.C. III, Ore transport and deposition in the Red Sea geothermal system: a geochemical model, 3:26120
Shannon, D.V., *See* Vickers, V.T., 3:26529
Shannon, J.D., Effect of the severe winter upon a cooling pond fog study, 3:26213
Shapiro, G., *See* Nagamiya, S., 3:27332
Shapiro, P.N., *See* Maslyanskii, G.N., 3:25772
Shapiro, S., *See* Gilchriese, M.G.D., 3:27138
Shapiro, S.M., *See* Mook, H.A., 3:26650
Shapiro, V.I., Optimal maintenance of main steam parameters in accordance with load of a generating unit, 3:26156
Shapovalov, Yu.I., *See* Shnitser, I.N., 3:26157
Sharbatova, G.S., *See* Bannik, B.P., 3:27118
Sharifian, H., *See* Gram, P.A.M., 3:27058
Sharma, T., *See* Swenson, L.W., 3:27342
Sharonov, Y.D., *See* Borozdin, V.S., 3:27082
Sharp, M.K., Stratified versus well-mixed sensible heat storage in a solar space heating application, 3:26079 (COO/4511—2, pp 17p, Paper 1)
See Loehrke, R.O., 3:26080
Shastry, C.S., *See* Jain, A.K., 3:27407
Shatin, S.A., *See* Trukhnii, A.D., 3:26173
Shavrov, P.I., *See* Goncharov, V.V., 3:26428
Shaw, B.W., *See* Knell, E.W., 3:25654
Shay, H.D., Energy and technology review, 3:27673 (UCRL—52000-77-8)
See Haas, R.A., 3:27448
Shay, J.L., Physics of InP/CdS solar cells, 3:26002
Shay, W.M., Instrumenting a pressure suppression experiment for a MK I boiling water reactor: another measurements engineering challenge, 3:26444 (UCRL—52314)
Shchelokov, V.I., *See* Aizen, Kh.K., 3:26165
Shchepkin, M.G., *See* Kobzarov, N.Y., 3:27219
Sheaff, M., *See* Heller, K., 3:27129
Shearer, J.W., Analytical estimates for higher energy neutral beams in MFTF, 3:27660 (UCID—17692)
Shebeko, A.V., Allowance for higher orders of the nuclear-surface deformation in calculations of elastic and inelastic nuclear form factors, 3:27395
Shelby, M.D., *See* Brown, M.M., 3:26994
Shelekhov, A.I., *See* Golovashkin, A.I., 3:26626
Shen, M.S., *See* Yang, R.T., 3:25710

Shen, Y.R., *See* Grant, E.R., 3:27047
See Sudbo, A.S., 3:27046
Shenoy, G.K., *See* Dattagupta, S., 3:26653
Shephard, W.D., *See* Biswas, N.N., 3:27132
Shepherd, A.D., *See* Dobson, J.E., 3:26932
Sherry, T.N., *See* Chiu, C.B., 3:27406
Sherstyuk, A.N., Effect of the radial gap on the efficiency of axial unshrouded turbine stages, 3:26163
Sherwood, G.G., GE tackles the nuclear island, 3:26217
Shestakov, E.N., Optical properties of metals at high temperatures, 3:26619
Shestopalov, V.P., *See* Gestryina, G.M., 3:27581
Sheth, A., *See* Finn, P.A., 3:26633
Shibata, T., Composition of neutral beam for heating JFT-2 plasma, 3:27434 (JAERI-M—6990)
Shih, L.L.L., Decay of mass-separated ^{122}Ag to levels in ^{122}Cd, 3:27363 (IS-T—795)
Shikanov, A.S., *See* Basov, N.G., 3:27689
Shikata, H., *See* Murata, Y., 3:25868
Shikhalizade, P.D., *See* Sitaraman, P.D., 3:25770
Shimizu, M., *See* Nakamura, H., 3:27614
Shimokawa, J., *See* Nomura, S., 3:26297
See Watanabe, H., 3:26311
Shimomura, Y., Model for heavy-impurity re-cycling at a limiter and limitation of power loss to a limiter in tokamaks, 3:27629
See Kimura, H., 3:27467
Shindoh, I., *See* Itoh, S., 3:26589
Shirakata, H., *See* Shibata, T., 3:27434
Shirane, G., *See* Ishikawa, Y., 3:26610
See Mook, H.A., 3:26650
See Tarvin, J.A., 3:26603
Shirley, D.A., *See* Ley, L., 3:26608
Shitsman, S.E., Some means of increasing efficiency of district heating in the tenth five-year period, 3:26546
Shlyakhovskii, I.D., *See* Melik-Akhnazarov, T.Kh., 3:25778
Shnitser, I.N., Development of the furnace process with various vortex burner arrangements, 3:26157
Shoffstall, D.R., Boiler burner design criteria for retrofit with low-Btu gases, 3:26778 (CONF-770885—1)
Shohet, J.L., *See* Talmadge, J.N., 3:27528
Sholin, G.V., *See* Oks, E.A., 3:27487
Shore, B.W., *See* Bialynicka-Birula, Z., 3:27086
See Eberly, J.H., 3:27085
Shpak, S.G., *See* Rusakov, M.M., 3:26613
Shpak, V.S., Improvements in or relating to power plant coolant, 3:26361
Shpil'rain, E.E., Specific electrical conductivity of liquid yttrium oxide at high temperatures, 3:26639
Shtur, V.B., Multifactor mathematical models of the core drilling-out process by lateral drilling core catchers, 3:25753
Shul'man, I.E., Manufacture of an experimental batch of convective heating surfaces for the Lithuanian district power station, 3:26183
Shuler, L.E., Displacement technique for calibration for special nuclear material tankage volumes, 3:26840 (RFP—2627)
Shumlyakovskii, Ts.I., *See* Swmylina, I.A., 3:25970
Shumyatskii, P.A., *See* Domnin, Yu.S., 3:26757
Shunk, E.R., *See* Veeser, L.R., 3:26819
Shvartsman, M.D., *See* Larionov, V.V., 3:27019
Shveikin, G.P., *See* Korshunov, I.G., 3:26615
Siarkiewicz, R., *See* Kozlowski, B., 3:25699
Sick, I., *See* Day, D., 3:27322
See McCarthy, J., 3:27378
Sidhu, D.P., *See* Mohapatra, R.N., 3:27250
Sidorenko, G.A., *See* Gorobets, B.S., 3:25905
Sieber, D.C., Effects of fast and thermal neutron flux and gamma radiation on the transmission characteristics of optical fibers. Interim report, 3:26659 (AD-A—042429)
Siegel, B., *See* Kroopnick, P.M., 3:26100
Siegel, S., *See* Kroopnick, P.M., 3:26100
Siegel, W., *See* Halpern, M.B., 3:27275
Siegmann, E.R., *See* Nickerson, G.M., 3:26476
Sierk, A.J., *See* Davies, K.T.R., 3:27380
Silbar, R.R., *See* Kloet, W.M., 3:27227
See Sternheim, M.M., 3:27329
Siler, W.C., Containment for small pressurized water reactors, 3:26227 (CONF-771109—90)
Silverman, A., *See* Bebek, C.J., 3:27104
Sim, J.W., *See* Ackerman, J.P., 3:26542
Siman-Tov, I.I., *See* Giles, G.E., 3:26594
Simenstad, C.A., Marine fish communities, 3:26927 (TID—26712, pp 451-492)
Simmons, J.M., US advanced LMFBR fuels development program, 3:26293
Simms, D.J., Geometric quantization of symplectic manifolds, 3:27423
Simon, A., Annual progress report, 3:27538 (COO—3497-24)
Simonov, A.P., *See* Abakumov, G.A., 3:26758
Simons, D.J., *See* Wolcott, J.H., 3:27044
Simpson, R.J., *See* Driver, P.M., 3:26064
Singer, H., *See* Chambers, L.E., 3:25831
Singer, M., Simple symmetry breaking in a chiral SU(4) x SU(4) model of pseudoscalar mesons, 3:27199
Singer, R., *See* Barish, S.J., 3:27116
Singh, M., *See* Genant, H.K., 3:26972
Singh, R.N., Creep behavior of mixed-carbide advanced nuclear fuel, 3:26635
Singh, T., *See* Beaudry, R. Jr, 3:26511
Singwi, K.S., *See* Jena, P., 3:26604
Sinha, S.K., *See* Harmon, B.N., 3:26611
Sink, D.A., *See* Chapin, D.L., 3:27642
Sinkevich, O.A., *See* Popel', O.S., 3:26536
Sionakides, G., *See* Raja, R., 3:27128
See Whitmore, J., 3:27139
Siskind, E., *See* Barish, B.C., 3:27115
Sisterson, L.K., *See* Bebek, C.J., 3:27104
Sitaraman, P.D., Improvement of some properties of diesel fuel distillates, 3:25770
Sitenko, A., Plasma theory. Report on the third international (Kiev) conference held at Trieste, 5 - 9 April 1977, 3:27527
Sitt, B., Fluid dynamic stability studies of laser imploded spherical shells, 3:27667 (CEA-CONF—3886)
Sitter, H., *See* Schwarz, H., 3:25929
Sjoedin, S., Self-motion and collective behaviour of classical one-component plasmas, 3:27579
Skalka, R.J., *See* Nayak, U.P., 3:26319
Skellett, S., *See* Hucklesby, R.J., 3:27696
Skhtoryan, E.S., *See* Abramyan, L.O., 3:27105
Skiens, W.E., *See* Franz, J.A., 3:25669
Sklizkov, G.V., *See* Basov, N.G., 3:27688, 3:27689
Skoeld, K., *See* Chen, S.H., 3:26592
Skogen-Hagenson, M.J., *See* Mullaney, P.F., 3:26961
Skopina, N.M., *See* Gun, R.B., 3:25789
Skubic, P., *See* Heller, K., 3:27129
Skvortsov, A.A., Main means of improving designs of heating networks, 3:26548
Slater, P.J., Permutations of the positive integers with restrictions on the sequence of differences, 3:27715
Slattery, P., *See* Chaney, D., 3:27121
See Mollet, W., 3:27123
Slivinskii, E.V., *See* Rozovskii, A.Ya., 3:25967
Slobodyanyuk, V.A., *See* Gus'kov, Y.K., 3:27081
Slonaker, J.F., Production of forty percent core area flyash brick using a lignite flyash, a northern West Virginia flyash, and a western Kentucky flyash. Report No. 112, 3:25682 (NP—23088)
Study of the effect of firing conditions upon flyash structural products. Report No. 128, 3:25683 (NP—23089)
Sloss, W., *See* Swanson, K.M., 3:26300
Sloss, W.M., *See* Bagley, K.Q., 3:26307
Sluyters, T., High energy neutral injectors based upon negative ion plasma sources, 3:26800 (BNL—23653)
Present status of negative ion acceleration and transportation from SP sources, 3:26799 (BNL—23652)
Smart, W.M., *See* Bogert, D., 3:27145
Smid, M., Investigations on effect of protecting pillars on coal and gas burst prevention in Ostrava-Karvina district coal mines, 3:25698
Smirnov, A.G., *See* Burtsev, V.A., 3:27460
Smirnov, B.P., *See* Aivazov, A.A., 3:26614
Smirnov, V.G., *See* Burtsev, V.A., 3:27460
Smirnov, Y.M., *See* Borozdin, V.S., 3:27082
Smith, A.Y., Uranium geochemical prospecting in Salzburg Province, Austria, 3:25922
Smith, B.A., Improved support for nuclear fuel rods, 3:26394
See Williamson, H.E., 3:26223
Smith, C.A., *See* Hamlin, D.A., 3:27039
Smith, C.L., *See* Spencer, D.W., 3:26930
Smith, D., Rubber mounts insulate whole reactor from 0.6 g earthquakes, 3:26459
Steam only from small reactor looks more attractive than coal, 3:26339
Smith, D.D., *See* Gilbert, R.O., 3:26912
Smith, E., *See* Iversen, S., 3:27335
Smith, F.T., Investigation of ion-ion recombination cross sections. Scientific report No. 2 (annual) 19 October 1975—18 October 1976, 3:27033 (AD-A—042185)
Smith, G.A., *See* Raja, R., 3:27128
See Whitmore, J., 3:27139
Smith, G.J., *See* Wells, J.C. Jr., 3:27357
Smith, H.H., Genus nicotiana as a genetic resource. Chapter 1, 3:26967 (BNL—23558)
Smith, H.I., *See* Ceglio, N.M., 3:27473
Smith, J., *See* Albright, C.H., 3:27190
Smith, K.D., *See* Reichmuth, H.S., 3:26014
Smith, L., *See* Stratton, R.W., 3:26310
Smith, M.F., Boiler corrosion (citations from the NTIS data base). Report for 1964—August 1977, 3:26153 (NTIS/PS—77/0795)
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Titanium and titanium alloy creep (a bibliography with abstracts). Report for 1964—September 1977, 3:26598 (NTIS/PS—77/0803)
Smith, P.D., COPAR, a program to compute release of metallic fission products from coated particles, 3:26254 (GA-A—14034)
Smith, R.A., Structural analysis methods and design solutions for OHMIC heating solenoids, 3:27641 (WFPS-TME—045)
Smith, R.J., Energy relationships for a 320-acre Iowa farm: an attempt to increase production of grain and meat while rendering the farm energy self-sufficient by generating methane through anaerobic fermentation of residues, 3:26020 (ERDA/USDA—19464/76/FR-3)
Smith, W.R., *See* Siler, W.C., 3:26227
Smither, R.K., Coulomb excitation experiments in ^{148}Sm, ^{150}Sm, ^{152}Sm, and ^{154}Sm, 3:27364 (ANL—77-60, pp 55-57)
Nuclear structure of the odd-N Sm isotopes, ^{145}Sm, ^{149}Sm, ^{151}Sm, ^{153}Sm, and ^{155}Sm, 3:27372 (ANL—77-60, pp 117-118)
Smithson, S.B., *See* Cermak, V., 3:26112
Smokowski, R.T., *See* Wilcox, D.P., 3:26889
Smol'skii, A.M., *See* Egiazarov, Yu.G., 3:25815
Smol'yaninova, N.M., Oil and gas condensate from Luginets field, 3:25795
Snape, G.P., *See* Bagley, K.Q., 3:26307
Snow, G.A., *See* Whitmore, J., 3:27139
Sobel'man, I.I., *See* Ilyukhin, A.A., 3:26749
Sochaski, R.O., *See* Puttagunta, V.R., 3:25894
Sodha, M.S., Nonlinear penetration of an inhomogeneous laser beam in an overdense plasma, 3:27449
Soesan, J.M., Legal problems of long term LNG contracts, 3:25863
Softley, D., *See* Stefun, R., 3:26149
Soille, P., *See* Bonfiglioli, G., 3:25849
Sokolineskii, Yu.A., *See* Egerev, V.V., 3:25972
Sokoloff, M.D., *See* Ballagh, H.C., 3:27114
Sokolov, A.A., *See* Volkov, G.G., 3:27237
Sokolov, Yu.A., *See* Buzankin, V.V., 3:27451
Sokolova, V.Yu., *See* Savin, V.I., 3:26545
Solberg, D.M., Safety and reliability of floating LNG production facilities, 3:25843
See Mathiesen, T.C., 3:25844
Solberg, J.E., *See* Maxam, G.L., 3:26841
Soldat, J.K., *See* Baker, D.A., 3:26992
See Brenchley, D.L., 3:26873, 3:26874
Solin, S.A., *See* Gorman, M., 3:26657
Solomkin, I.K., *See* Nikitin, S.A., 3:26625
Solomon, P.R., New method for sulphur concentration measurements in coal and char, 3:25670
Solomon, S.M., Developments in olefins production technology, 3:25767
Solovei, A.B., *See* Bursak, A.V., 3:27387
Sombor, A., *See* Ambrus, Gy., 3:26373
Sommer, J., *See* Koeppendoerfer, W., 3:27535
Sonnerup, L., *See* Bourrier, P., 3:27694
Sontheimer, R.F., *See* Funk, W.T., 3:26719
Soper, W.G., Efficiencies of various methods for solar energy conversion, 3:25986 (AD-A—042584)
Sosin, A., European developments in the Na/S high- temperature battery for automobile propulsion and energy storage, 3:26487 (AD-A—042541)
Sosna, M.Kh., *See* Egerev, V.V., 3:25972
Sotnikov, I.A., Improvement of the design of Type P-57 boiler relying on the experience of its operation at the troitskaya district power station, 3:26164
Sotomayor, R.E., Procedures for the detection of unscheduled DNA synthesis in the germ cells of mole mice exposed in vivo to chemical mutagens, 3:26996 (TID—28142)
Southworth, F.H., Plasma studies of a catalyzed-D noncircular tokamak, 3:27655 (EUR—5602, pp 393-398)
Spalding, I.J., Improvements in or relating to fusion nuclear reactors, 3:27661
Speake, C.J. Jr, *See* Finch, T.E., 3:25692
Specht, J.R., *See* Bowles, T., 3:27334
Spedding, P.L., Solar building panel concept for the supply of hot water, 3:26055
Speece, R.E., Effect of molecular structure on methane fermentability, 3:26006 (COO/2991—19, pp 5-6)
Speiser, D., *See* Levy, M., 3:27292
Spejewski, E.H., *See* Cole, J.D., 3:27370
Spelbring, D., *See* Chaney, D., 3:27121
Spence, E.W., Some problems in installing, commissioning and maintaining instrument systems in an offshore environment, 3:26784
Spencer, B.W., *See* Holtz, R.E., 3:26432
Spencer, D.W., Distribution of some chemical elements between dissolved and particulate phases in the ocean. Period covered: August 1, 1976—October 31, 1977, 3:26930 (COO—3566-19)
Spencer, R.R., Enhancement of methane production with activated carbon, 3:26012 (COO/2991—19, pp 53-56)
Sperling, J.L., Electron Landau damping and electron collisions, 3:27571
Quasi-linear diffusion and particle transport in inhomogeneous plasmas, 3:27510
Sperr, P., *See* Kovar, D.G., 3:27351
Spivack, H., *See* Fischbach, E., 3:27200
Spodyryak, N.T., *See* Rudenko, I.m., 3:26168
Spong, D.A., *See* Hedrick, C.L., 3:27605
Springer, T., *See* Vant-Hull, L., 3:26034
Sprott, J.C., *See* Barter, J.D., 3:27450
Squires, A.M., *See* Lee, K.C., 3:25677
Srebrodol'skii, D.M., *See* Tsvetov, V.V., 3:25763
Sreedhar, V.A., *See* Biswas, N.N., 3:27132
Srikrishnan, V., *See* Pecora, L.M., 3:25685
Srour, J.R., Ionizing radiation effects on silicon-on-sapphire devices and silicon dioxide films. Final report May 76—Apr 77, 3:26836 (AD-A—046169)
St. Lorant, S.J., Biomagnetism: a review, 3:27002 (SLAC-PUB—1984)
Stach, H., *See* Haferkamp, D., 3:26382
Staehle, J.T., *See* Shay, H.D., 3:27673
Stahl, G.A., *See* Helbert, J.N., 3:26693
Stair, A.T. Jr, *See* O'Neil, R.R., 3:27035
Stang, P.J., Unsaturated carbenes from primary vinyl triflates. IX. Intramolecular rearrangement via free carbenes, 3:26685
Stankevich, V.A., *See* Melik-Akhnazarov, T.Kh., 3:25778
Stapleton, H.J., *See* Boldu O., J.L., 3:26631
Stavinoha, L.L., Review of diesel fuel deterioration and related problems. Interim report, 3:25812 (AD-A—043566)
Stavtsev, A.L., Structural knots: important elements of structural boundaries of ancient platforms, 3:27007
Steel, D., *See* Yaakobi, B., 3:27474
Stefun, R., Closed gas turbine heater program. Second quarterly technical progress report, July 4, 1977—October 2, 1977, 3:26149 (TID—28200)
Steinbeck, *See* Brown, 3:26024
Steinberg, M., *See* Yang, R.T., 3:25710
Steiner, H., *See* Nagamiya, S., 3:27332
Steinhauer, L., Anomalous transport effects in magnetically-confined plasma columns, 3:27439
Steinhauer, L.C., Endloss from a slender high-beta plasma column contained in a linear solenoid, 3:27466
See Krakowski, R.A., 3:27454
Steinkamp, J.A., *See* Mullaney, P.F., 3:26961
Steinke, R.G., *See* Smith, P.D., 3:26254
Stejskal, E.O., *See* Bartuska, V.J., 3:25668
Stekhun, A.I., Chemical composition of naphthas from coking of petroleum residues, 3:25820
Stella, P., *See* Scott-Monck, J., 3:25987
Stelson, P.H., *See* Ronningen, R.M., 3:27373
Stenger, V.J., *See* Ballagh, H.C., 3:27114
Stepanov, V.A., *See* Zabortseva, T.A., 3:26751
Stephen, J.D., LIFE code system for analysis of oxide fuel pin thermal/structural behavior, 3:26320
Stephens, J.R., Materials technology assessment for Stirling engines, 3:26578 (CONS/1011—22)
Stephenson, G.J. Jr., *See* Goldman, T., 3:27197
Sternheim, M.M., Neutron and proton knockout from ^{19}F and ^{27}Al by negative pions, 3:27329
Sternheimer, R.M., Ordering of the excited-state energy levels of various atoms and their isoelectronic ions. II, 3:27053
Stevens, A.J., *See* Lindquist, J., 3:27117
Stevenson, M.L., *See* Ballagh, H.C., 3:27114
Stewart, L.D., Neutral beam injector research and development work in the USA, 3:27663
Stickley, R.A., *See* Anderson, D.E., 3:26076
Sticksel, P.R., *See* Schorr, J.R., 3:26882
Stiglich, J.J. Jr., Study program to develop and evaluate die and container materials. First quarterly report, October 1977—December 1977, 3:25988 (DOE/JPL/954877—1)
Stockdale, J.A.D., *See* Warmack, R.J., 3:27066
Stodiek, W., *See* Sauthoff, N.R., 3:27469
Stokstad, R.G., Mechanisms for Li and Be production in the ^{14}N + ^{12}C reaction, 3:27336
Stone, C., Geology and chemistry of Hawaii geothermal project well-A, Kilauea Volcano (abstract), 3:26086
Storm, E., *See* Cortez, J.R., 3:26824
Stotskii, G.I., *See* Ivanov, R.S., 3:26744
Stott, P.E., *See* Fielding, S.J., 3:27625
Stottlemyer, A.R., *See* Briefel, E., 3:27140
Stowers, I.F., *See* Jones, W.A., 3:27671
Strakhova, S.I., *See* Mishchenko, T.V., 3:27083
Stramkovskaya, K.K., *See* Smol'yaninova, N.M., 3:25795
Strappa, O., Environmental effect of mercury, with particular attention to the Monte Amiata Zone, 3:26885 (ORNL-tr—4479)
Stratton, R.W., Development of advanced fuels in Switzerland, 3:26298
Irradiation behavior of sphere-pac carbide fuel, 3:26310
Straume, T., Underground pressure suppression system for Boiling Water Reactors (BWRs), 3:26212 (UCID—17695)
Strausz, O.P., *See* Selucky, M.L., 3:25900
Strebig, K.C., *See* Roepke, W.W., 3:25700
Streich, M., *See* Pocrnja, A., 3:25839

Stroganov, V.P., Regularities in the arrangement and formation conditions of zones of oil and gas accumulation in jurassic deposits of south Russia, 3:25744
Strongin, M., *See* Wiesmann, H., 3:26602
Stuart, G.W., *See* Hedrick, C.L., 3:27605
Stuart, J.D., *See* Williamson, H.J., 3:26881
Stuckey, D., *See* Healy, J., 3:26007
Stump, D.R., Quark confinement and field theory, 3:27160
See Huang, K., 3:27290
Sturman, B.I., Plasma turbulence near the low hybrid resonance, 3:27588
Stutte, L., *See* Barish, B.C., 3:27115
Styles, R.C., *See* Saltmarsh, M.J., 3:26794
Styrikovich, M.A., Experimental study of heat exchange in the transcritical region of smooth and rough steam-generating channels, 3:26707
Suaya, R., Corrections to the two-gluon annihilation rates of paracharmonium states, 3:27177
Suckewer, S., Plasma edge cooling during RF heating, 3:27436 (PPPL—1416)
Spectroscopic measurements of ion temperature in ATC tokamak with RF and neutral-beam heating, 3:27478
Suda, Y., *See* Ogawa, K., 3:26095
Sudarshan, E.C.G., Unitary unified field theories, 3:27309
Sudbo, A.S., Multiphoton dissociation products from halogenated hydrocarbons, 3:27046
See Grant, E.R., 3:27047
Sugawara, T., *See* Shibata, T., 3:27434
Sugiyama, K., *See* Ozaki, K., 3:25618
Sukhotin, A.M., *See* Shpak, V.S., 3:26361
Sukhov, V.A., *See* Treshchev, G.G., 3:26178
Suleiman, S.A., Morphology and ultrastructure of spermatozoa of the ticks, 3:26980 (CONF-770504—, pp 159-165)
Sultanov, B.Z., *See* Yanturin, A.Sh., 3:25754
Sulton, A.L., *See* Huszar, L., 3:27400
Sumner, R.L., *See* Lindquist, J., 3:27117
Sumskaya, A.I., *See* Stekhun, A.I., 3:25820
Sun-Tszin-Yan, G.Y., *See* Bannik, B.P., 3:27118
Sung, T.Y., *See* Avci, H.I., 3:27618
Suntsov, A.N., *See* Akimov, Yu.I., 3:26161
Suprunenko, O.I., Possible association between intensity of modern volcanism and horizontal movements of the crust in eastern Kamchatka, 3:27008
Surunyan, A.M., *See* Abramyan, L.O., 3:27105
Sutter, L.V. Jr., Analysis of continuous electron gun pre-ionized electric laser discharges, 3:26763
Sutton, R.B., *See* Roberson, P., 3:27130
Suuberg, E.M., *See* Bush, T.W., 3:25619
Suura, H., *See* Geffen, D.A., 3:27154
Suvorova, N.G., *See* Kaliberdo, L.M., 3:26678
Suydam, B.R., *See* Carasso, A., 3:27506
Suz'ko, A.A., *See* Zakhar'ev, B.N., 3:27311
Suzuki, K., Relaxation of variable torque in the shafting for LPG compressors, 3:25834
Suzuki, M., *See* Yamada, R., 3:26387
Suzuki, Y., *See* Kameari, A., 3:27635
Suzuki, Yasuo, *See* Aikawa, Hiroshi, 3:27468
Svalgaard, L., *See* Duvall, T.L. Jr, 3:27025
Sviatoslavsky, I.N., *See* Michaelson, P.F., 3:27640
Svreck, F., *See* Whitmore, J., 3:27139
Swallow, E.C., *See* Lindquist, J., 3:27117
Swanson, J.L., *See* Burke, J.C., 3:26048
Swanson, K.M., Fuel element for fast nuclear reactors, 3:26328
UK irradiation experience relevant to advanced oxide fuel concepts for LMFBR's, 3:26300
Swanson, R., *See* Prettie, C., 3:27041
Swaroop, R., *See* Ackerman, J.P., 3:26542
Swartzbaugh, J.T., Best mixing concepts for refuse/sludge for ERDA's biogasification project, 3:26013 (COO/2991—19, pp 57-62)
Sweetman, N., *See* Johnson, A.C., 3:26522
Swenson, L.W., Coincidence measurements of quasielastic pion scattering by ^{27}Al and ^{208}Pb, 3:27342
See Iversen, S., 3:27335
Swetland, P.J., *See* Clayton, J.L., 3:25741
Swider, G.M., *See* Ballagh, H.C., 3:27114
Swmylina, I.A., Conditions for regenerating an iron—molybdenum—tungsten catalyst used in ammonia synthesis, 3:25970
Sych, Yu.I., *See* Isaev, V.N., 3:25777
Szabo, J., *See* Nagy, O., 3:26408
Szczekowski, M., *See* Barish, S.J., 3:27116
See Derrick, M., 3:27125
Sze, R.C., Performance characteristic of discharge excited excimer lasers, 3:26737 (LA-UR—77-328)
Szkuta-Pochopien, T., *See* Boduszynski, M., 3:25781
Szuszczewicz, E.P., Observations of electron temperature gradients in mid-latitude E sub S layers. Revision. Interim report, 3:27036 (AD-A—042501)

T

Taber, A.M., Synthetic methods of using secondary pyrolysis by-products, 3:25792
Tabor, S.L., Systematics of O + Mg fusion, 3:27340 (ANL—77-60, pp 40-41)
See Davids, C.N., 3:27355
See Geesaman, D.F., 3:27350
See Jackson, H.E., 3:27323
Tada, B., Insulation system for low temperature service double wall tank, 3:25885
Taguchi, Y., *See* Hori, K., 3:26196
Tai, A.S., Neutron transit time measurements on a two-different-core system, 3:26355
Tajima, Y., Tables of chemical analysis of mineral waters (1961—1966) from the Hot Spring Research Institute of Kanagawa Prefecture, 3:26104
Takabatake, T., *See* Hori, K., 3:26781
Takach, F., *See* Liptak, L., 3:25927
Takahashi, K., *See* Tada, B., 3:25885
Takami, K., Studies on catalysts for low-temperature steam-reforming of hydrocarbons. IV. Kinetics of reaction on the Rh-$MgWO_4$ catalyst, 3:25784
Takano, O., *See* Yamaguchi, T., 3:25866
Takashima, T., *See* Morishita, O., 3:27702
Takasugi, E., *See* Hagiwara, T., 3:27148
Takatsu, H., *See* Morishita, O., 3:27702
Takeda, S., Plan and design of ETL TPE-2 experiment, 3:27595 (EUR—5602, pp 245-250)
Takizuka, T., *See* Momota, H., 3:27433
Talmadge, J.N., Magnetohydrodynamic equilibria of a non-circular cross-section stellarator, 3:27528
Tamura, S., *See* Kobayashi, T., 3:27615
Tamura, T., Plutonium distribution in a desert pavement-desert mound soil system in area 11, 3:26910 (NVO—171, pp 1-15)
Tan, C.I., *See* Feldman, D., 3:27146
Tanabe, T., *See* Tanaka, S., 3:25867
Tanaka, H., *See* Sato, K.N., 3:27427
Tanaka, N., *See* Iversen, S., 3:27335
See Swenson, L.W., 3:27342
Tanaka, S., Movements and stress characteristics of LNG piping, 3:25867
Tandanand, S., *See* Olson, J.J., 3:25695
Tandy, P.C., Three-body approach to the single-scattering optical potential, 3:27394
Tanguy, J.C., *See* Archambault, C., 3:26088
Tani, K., *See* Kobayashi, T., 3:27615
Tanihata, I., *See* Nagamiya, S., 3:27332
Tanner, R.L., Chemical composition of sulfate as a function of particle size in New York summer aerosol, 3:26872 (BNL—23672)
Tarakanov, V.P., *See* Al'terkop, B.A., 3:27585
Taroni, A., *See* Bertolini, E., 3:27624
Tarter, C.B., *See* Jensen, R.V., 3:27627
Tarvin, J.A., High-temperature spin dynamics in an amorphous ferromagnet, 3:26603
See Ishikawa, Y., 3:26610
Tasso, H., Energy principles for non-ideal MHD, 3:27551
Tatarenkov, V.M., *See* Domnin, Yu.S., 3:26757
Tate, C.H. Jr, *See* Fontane, D.G., 3:26481
Tatebayashi, J., *See* Hori, K., 3:26781
Tatterson, D.F., *See* Vasalos, I.A., 3:25659
Taube, H., *See* Agarwala, U., 3:26699
Taubert, G., Applications of interference microscopy for measurements on the cell nucleus in comparison with impulse cytophotometry, 3:26966 (LA-tr—78-4)
Taubin, M.L., *See* Danil'chenko, V.V., 3:26616
Taussig, R.T., *See* Krakowski, R.A., 3:27454
Taylor, D.A., *See* Hickok, W.W., 3:26130
Taylor, J.B., *See* Connor, J.W., 3:27461
Taylor, J.C., *See* Cheetham, A.K., 3:26680
Taylor, R.E., Deep inelastic electron and muon scattering, 3:27169 (SLAC-PUB—1613)
Taylor, R.J., *See* Oren, L., 3:27628
Taylor, R.W., Multiple seismic events, 3:26861 (AD-A—042571)
Tazima, T., *See* Kobayashi, T., 3:27615
See Nakamura, Y., 3:27505
Tegeback, R., *See* Gradov, O.M., 3:27577
Telkes, M., Selective black for absorption of solar energy, 3:26067
Teo, B.K., Determination of local structures of platinum uridine blues and purples by extended x-ray absorption fine structure spectroscopy, 3:26675
Ter-Mikaelyan, M.L., *See* Gyuzalyan, R.N., 3:26756
Tereshina, I.V., Crude oils of the Georgian SSR, 3:25819
Terhune, R.W., *See* McKee, C.R., 3:25702
Terrell, J., Fluctuations of quasars and other astronomical sources: final report on New Research Initiatives Program W-210, 3:27024 (LA—7092-MS)
Terry, J.L., Observation of poloidal asymmetry in impurity-ion emission due to del B drifts, 3:27446
Tesitor, C.N., Design and operation of air-lift, circulated, cascade dissolver systems, 3:26667 (RFP—2716)
Testa, F.J., *See* Holtz, R.E., 3:26432
Tetenbaum, M., Some observations on oxygen and carbon potentials in U—Pu—O and U—Pu—C systems, 3:26599
Tetreault, D.J., *See* Dupree, T.H., 3:27509
Tewari, S.K., Wind power for india, 3:26125
Thacker, H.B., Statistical mechanics of a (1 + 1) -dimensional quantum field theory at finite density and temperature, 3:27276
Theodosiou, C.E., Nonresonant and resonant electron distributions from

fast particle collisions: Application to sodium, 3:27069
Thibideau, F.D., Pulsed neutron generator for logging, 3:25908
Thiel, R., *See* Heller, H., 3:25786
Thiele, U., *See* Alekseevskii, N.E., 3:26655
Thiessen, H.A., *See* Iversen, S., 3:27335
See Swenson, L.W., 3:27342
Thimons, E.D., *See* Vinson, R.P., 3:25691
Thom, R., Symmetries gained and lost, 3:27424
Thomas, D., *See* Kroopnick, P.M., 3:26100
Thomas, G.H., *See* Johnson, P.W., 3:27208
Thomas, L., *See* Froeba, K., 3:26891
Thomas, M.G., Hydrogen consumption in non-catalyzed coal liquefaction, 3:25664 (SAND—77-1560C)
See Granoff, B., 3:25663
Thomas, N.L., Comparative performance of silicon and gallium arsenide solar cells on a high altitude sounding rocket, 3:25998
Thome, Z.D., *See* Ferreira, E.M., 3:27230
Thompson, A., *See* Jaklevic, J.M., 3:26879
Thompson, A.S., *See* Fraas, A.P., 3:27617
Thompson, F.O. Jr., Rainout, 3:26886 (AD-A—046201)
Thompson, G.E.K., Temperature gradients within the adjacent to the North Island volcanic belt, 3:26096
Thompson, M.A., *See* Whitmore, J., 3:27139
Thompson, P.B., *See* Nelms, L.W., 3:27636
Thompson, S.L., Installation independent version of the Sandia SCORS plot system, 3:27706 (SAND—77-1179)
Thomson, D.A., *See* Vasilik, D.G., 3:26888
Thorn, C.E., *See* Kovar, D.G., 3:27341
Thorndike, A.M., *See* Ludlam, T., 3:26810
Thorngate, J.H., Optimization of the detector and associated electronics used for high-resolution liquid-scintillation alpha spectroscopy, 3:26829
Thorsos, E., *See* Yaakobi, B., 3:27474
Tilbury, R.S., *See* Laughlin, J.S., 3:26971
Timbs, A.E., *See* Ashcroft, D.J., 3:26225
Timchenko, A.V., *See* Nekrasov, V.G., 3:26167
Timoshenko, A.P., *See* Iremashvili, D.V., 3:27486
Tindale, J.B., Method and device for inserting a multitude of fuel rods into a fuel element frame, 3:26392
Tingey, G.L., *See* Franz, J.A., 3:25669
Tishchenko, V.A., *See* Glukhikh, V.A., 3:27650
Titirichi, M., *See* Bugrov, V.N., 3:27382
Tjostheim, D., New measure of association for spatial variables. Technical report No. 7, 3:26876 (COO—2874-16)
Tochilin, E., *See* McCall, R.C., 3:26820
Todorov, I.T., Conformal expansion for Euclidean Green functions, 3:27305
Todreas, N., *See* Masterson, R., 3:26279
Todreas, N.E., *See* Basehore, K.L., 3:26405
See Chiu, C., 3:26281
See Mikic, B., 3:26280
Toegl, K., *See* Schuengel, P., 3:26375
Toennessen, A., Spherical LNG tanks on continuous cylindrical skirts: a shipbuilder and licenser's experience, 3:25879
Toepfer, A.J., *See* Ramirez, J.J., 3:26793
Tohver, H.T., *See* Chen, Y., 3:26596
Tokar, M.Z., *See* Volkov, T.F., 3:27518
Tokareva, A.N., *See* Basov, Yu.G., 3:26754
Tolnas, E., *See* Bretz, N., 3:27472
Tolstov, K.D., *See* Bannik, B.P., 3:27118
Tominaga, H., Hydrovisbreaking of Athabasca bitumen and its reaction mechanism, 3:25899
Tominaga, S., *See* Hori, K., 3:26196
Tomiyama, S., *See* Ozaki, N., 3:25920
Tomkins, F.S., *See* Fonck, R.J., 3:27048
Tompkins, J., *See* Briefel, E., 3:27140
Tone, T., *See* Maki, K., 3:27432
Tongish, C.A., *See* Moffitt, R.L., 3:25882
Tonn, J.F., Low-lying states in ^{39}Ar from the ^{37}Cl(α,d)^{39}Ar reaction, 3:27345
Toor, A., *See* Zarnecki, J.C., 3:27030
Toothacker, W.S., *See* Lys, J.E.A., 3:27126
Tootoonchi, H., *See* Gram, P.A.M., 3:27058
Toppings, R., *See* Louis, J.F., 3:26145
Torgasheva, A.A., *See* Kaliberdo, L.M., 3:26678
Torocheshnikov, N.S., *See* Govorov, V.V., 3:26787
Toth, K.S., *See* Cole, J.D., 3:27370
Touche, J., *See* Hennion, F., 3:27695
Tovma, V.A., *See* Zenkevich, V.B., 3:26539
Towner, H.H., *See* Goldston, R.J., 3:27592
Townsend, J., *See* Suaya, R., 3:27177
Tracy, D.H., *See* Fonck, R.J., 3:27048
Trainito, G., *See* Bombi, F., 3:27693
Trainor, D., Metal vapor visible laser kinetics program. Final technical report, 3:26716 (AD-A—042271)
Tratz, H., Feed water pre-heater with two steam spaces, 3:26224
Travis, B.J., *See* Davis, A.H., 3:26085
Treglio, J.R., Conditions for a boron fusion reactor in the MeV range, 3:27662
Treiman, S.B., *See* Holstein, B.R., 3:27252
Treshchev, G.G., Flow stability in heated channels in the transcritical region of the parameters of state, 3:26178
Trimmer, D.A., *See* Dengler, L.A., 3:26119
Tripathi, V.K., *See* Sodha, M.S., 3:27449
Trippe, T.G., *See* Scharre, D.L., 3:27113
Trokhachov, G.V., *See* Glukhikh, V.A., 3:27645, 3:27650
Tropkin, E.N., *See* Birman, A.Y., 3:26747
Troshin, S.M., Growth of the average multiplicity with increasing transverse momentum, 3:27238
Trout, J.J., Enzyme localizations in hepatocytes following triton WR-1339 injection, 3:26954 (CONF-770504—, pp 60-71)
Trubnikov, B.A., *See* Vikhrev, V.V., 3:27517
Trujillo, D.M., Finite element nonlinear heat transfer analysis using a stable explicit method, 3:26349
Trukhnii, A.D., Concentration of temperature stresses in thermal grooves of integral-disk rotors, 3:26173
Trussell, H.J., Image restoration of space variant blurs by sectioned methods, 3:27705 (LA-UR—77-2876)
Trykova, V.I., *See* Biryukov, N.S., 3:27354
Tsang, K.T., Analytic solutions of the two-dimensional eigenvalue problem for the trapped-electron instability in tokamaks, 3:27445
Tsarev, P.P., *See* Glushchenko, N.F., 3:26760
Tsiklauri, G.V., *See* Rassokhin, N.G., 3:26773
Tsugeno, H., *See* Ozaki, K., 3:25618
Tsuji, H., *See* Saito, H., 3:27457
Tsvetov, V.V., Geologo-technical efficiency of rising thermometry and radioisotopes in investigation of pumping wells in Tataria, 3:25763
Tsybulevskii, A.M., Optimal conditions for selective hydrocracking of raffinates, 3:25773
Tsymarnyi, V.A., *See* Golovskii, E.A., 3:25818
Tuchin, V.V., Modulation spectroscopy of He—Ne laser levels, 3:26746
Tuda, T., Temperature gradient effect on impurity-ion transport, 3:27504 (JAERI-M—6965)
Tudron, T.N., *See* Creutz, M., 3:27254
See Monsay, E.H., 3:27260
Tugov, A.I., *See* Avrutskii, G.D., 3:26172
Turbett, J.R., Application of a GC/MS data system at Rocky Flats, 3:26839 (RFP—2558)
Turchi, P.J., *See* Book, D.L., 3:27600
See Cooper, A.L., 3:27536
Turk, M., Monfort waste conversion demonstration. Progress report, April 1, 1977—June 4, 1977, 3:26016 (COO/2991—19, pp 85-98)
Turkevich, J., *See* Iton, L.E., 3:26698
See Miner, R.S. Jr., 3:26684
Turnbull, L.S. Jr, Vela network evaluation and automatic processing research. Final report, 1 July 1975—30 October 1976, 3:26860 (AD-A—042275)
Turnbull, R.J., *See* Foster, C.A., 3:27664
Turner, A.K., *See* Wecksung, M.J., 3:26917
Turner, E.B., Annular iodine laser facility. Interim report, 3:26717 (AD-A—042282)
Temporal stability of single-line cw HF chemical laser with unstable resonator. Interim report, 3:26722 (AD-A—042458)
Turner, F.E., *See* Cole, J.D., 3:27370
Turner, R.H., *See* Fujita, T., 3:26038
Tuszewski, M., Transient confinement of a high-density plasma in a multiple-mirror magnetic-field configuration, 3:27463
Tveit, O.J., *See* Mathiesen, T.C., 3:25844
Twogood, R.E., *See* Ekstrom, M.P., 3:27711
Tye, S.H., *See* DeGrand, T.A., 3:27176
See Ng, Y.J., 3:27157
Tyutin, F.G., Underground investigation of the hydraulic fracture zone along the iota$_7$ seam at the Lisichansk Podzemgaz Station, 3:25705 (UCRL-Trans—11318)

U

Uchida, M., *See* Watanabe, H., 3:26311
Uchida, T., *See* Inoue, N., 3:27453
Uckan, N.A., *See* Peng, Y.K.M., 3:27637
Uckan, T., Small radius start-up of tokamak plasmas with a moving limiter, 3:27435 (ORNL/TM—6111)
Udovichenko, Yu.K., *See* Iremashvili, D.V., 3:27486
Ueda, K., Brittle fracture initiation characteristics of thin mild steel plate for the gas barrier of LNG underground membrane tank, 3:25884
Ueda, N., *See* Kimura, H., 3:27613
Uematsu, K., *See* Nomura, S., 3:26297
Uematsu, K. Ishida, Y., Experience and future plan of fast reactor oxide fuels irradiation in Japan, 3:26301
Ueyanagi, K., *See* Ozaki, N., 3:25920
See Yamada, K., 3:25918, 3:25919
Uhm, H., Influence of axial energy spread on the negative-mass instability in a relativistic nonneutral E layer, 3:27547
Ulbricht, A., Dynamic behavior of a resistive transfer circuit with a superconducting switch, 3:27647 (EUR—5602, pp 765-769)
Ulehla, M.K.V., Theory of radiative electron capture by channeled ions, 3:27404
Ulwick, J.C., *See* O'Neil, R.R., 3:27035
Umble, D.G., *See* Gilman, J.D., 3:26207
Umemura, J., *See* Ishimasa, Y., 3:25886
Underwood, D., *See* Chaney, D., 3:27121
See Mollet, W., 3:27123
Unger, D.G., *See* Mahanthappa, K.T., 3:27191
Uno, F., *See* Scott-Monck, J., 3:25987
Urban, M., What will the fast breeder bring us. As an important interlude, nuclear power utilization may be prolonged by fast breeders: but it may also end as a catastrophe, 3:26457
Uresk, D.W., Biotic components, 3:25946 (PNL—2253, pp 3.1-3.40)
See Paine, D., 3:25949
See Sauer, R., 3:25950
Uresk, V., *See* Paine, D., 3:25951
Uresk, V.A., Introduction, 3:25944 (PNL—2253, pp 1.1-1.18)

See Cline, J.F., 3:26908
Usher, J., Wet steam turbines for nuclear generating stations -design and operating experience, 3:26273
Ushveridze, A.G., Conformal-invariant behavior of four-point theories in the ultraviolet limit, 3:27287
Usnick, G.B., *See* Lewis, H.E., 3:25648
Ustalov, V.V., *See* Lisitchenko, V.V., 3:27586
Uto, H., *See* Amaldi, E., 3:27133

V

Vailov, G.M., *See* Shul'man, I.E., 3:26183
Vainshtein, Yu.D., Methods of protection of obviate hazardous sparkaing in explosion-proof luminaries with fluorescent lamps, 3:25725
Valat, J.L., *See* Avias, J., 3:26101
Valdez, R.A., Aquatic ecology, 3:26924 (TID—26712, pp 287-313)
Valeo, E.J., *See* Albritton, J.R., 3:27683
Valerio, J.I., *See* Hamlin, D.A., 3:27040
Valette, L., Refuelling system for a nuclear reactor with a reactor core showing (presenting) a pebble bed of spherical fuel elements, 3:26261
Refuelling system for a nuclear reactor with a reactor core exhibiting a pebble bed of spherical fuel elements, 3:26267
Valiknac, T., *See* Neufeld, R.D., 3:26947
Van Hook, R.I., Transport and transformation pathways of hazardous chemicals from solid waste disposal, 3:26875 (CONF-7710114—1)
Van Huisen, A.T., Multiple-completion geothermal energy production systems, 3:26105
van Nooijen, B., *See* Cole, J.D., 3:27370
See Ronningen, R.M., 3:27374
Van Soest, P.J., *See* Jewell, W.J., 3:26010
Vander Klay, A.P., *See* Vasalos, I.A., 3:25659
Vanderborgh, N.E., *See* Carter, W.J., 3:25859
Vanderpoorten, J.E., B77 GTU-8D full scale static load test of thinned wall titanium afterbody: SLL test No. 7411-3, 3:26859 (SAND—77-8291)
VanderVelde, J.C., *See* Lys, J.E.A., 3:27126
VanKuiken, J.C., *See* Dux, C.D., 3:25720
Vant-Hull, L., Liquid metal cooled solar central receiver feasibility study and heliostat field analysis. Part I. Liquid sodium cooled central receiver system conceptual design. Final report, 3:26034 (ORO/5178—78-1)
Vant-Hull, L.L., Development of solar tower program in the United States, 3:26036
Educated ray trace approach to solar tower optics, 3:26037
Varga, R.S., *See* Saff, E.B., 3:27714, 3:27716
Vargas, M., Experimental verification of a theory of the current sheath in the plasma focus, 3:27485
See Gratton, F., 3:27495
Varghese, P., *See* Iversen, S., 3:27335
See Swenson, L.W., 3:27342
Varma, M.N., Dependence of anti W on the charge of heavy ions, 3:27057 (BNL—23394)
Varnell, L., *See* Ronningen, R.M., 3:27373
Varshaver, E.M., Increasing the efficiency of production of high. VI. Residual lube oils from Mangyshlak crude, 3:25788
Vartapetyan, G.A., *See* Abramyan, L.O., 3:27105
Vary, J.P., *See* Moffa, P.J., 3:27328
Vasalos, I.A., Study of ebullated bed fluid dynamics for H-coal. Monthly progress report No. 4, December 1—December 31, 1977, 3:25659 (FE—2588-4)
Vasil'ev, Kh.K., *See* Aizen, Kh.K., 3:26165
Vasil'eva, T.N., *See* Ol'kov, P.L., 3:25769
Vasilik, D.G., Integrated minicomputer alpha analysis system, 3:26888 (LA-UR—77-2968)
Vasserman, L.K., *See* Varshaver, E.M., 3:25788
Vater, W., Instructions for treating internal coatings of man-sized pipes and containers, 3:26552
Vaughan, B.E., *See* Cataldo, D.A., 3:25948
Veal, H.K., Exploration frontiers of the central and southern Rockies, 3:25729
Vecchio, J., *See* Cooper, F., 3:25684
Veeser, L.R., Calibration of a detector for pulsed neutron sources, 3:26819 (LA—7022-MS)
Cross sections for (n,2n) and (n,3n) reactions above 14 MeV, 3:27353
Veillet, J.J., *See* Jonckheere, A.M., 3:27144
Vekshtejn, G.E., Theory and calculations of non-magnetic dense-plasma confinement, 3:27458
Velez, W.Y., *See* Slater, P.J., 3:27715
Venier, D.A., *See* Lass, J.L., 3:26403
Venolia, C., Community leaders workshop on solar energy assessment. Final report, 3:25982 (RLO/2230/T5—1)
Venot, R., *See* Lleres, J., 3:26286
Verbinski, V.V., Neutron dosimetry standard. Final report, 1 May 1974—30 October 1975, 3:27403 (AD-A—042276)
Verdieck, J.F., *See* Eckbreth, A.C., 3:26701
Vergados, J.D., *See* Goulard, B., 3:27326
Verhage, A.J.L., *See* Butt, E.P., 3:27631
Verma, J.S., Effect of plasma on radiative sources, 3:27488
Vermaseren, J.A.M., *See* Albright, C.H., 3:27190
Verolme, C., 330000 m3 Verolme LNG carrier, 3:25877
Vershkov, V.A., *See* Buzankin, V.V., 3:27451
Vertogradskii, V.A., Integral hemispherical degree of blackness of alloys of high-melting metals at high temperatures, 3:26622
Vet, P.N., *See* Bijl, P., 3:25852
Vetrov, V.V., *See* Abakumov, G.A., 3:26758
Vetter, R.L., *See* Smith, R.J., 3:26020
Vickers, V.T., Energy use in the dairy industry (report No. 25), 3:26529 (NP—23050)
Vidale, R.J., *See* Charles, R.W., 3:26121
Vieira, D.J., *See* Cerny, J., 3:26803
Vigdor, S.E., *See* Kovar, D.G., 3:27351
Vikhrev, V.V., Dynamics of a non-cylindrical Z-pinch and the particle acceleration mechanism, 3:27517
Viles, J.M., Myopathy associated with a murine Sarcocystic infection, 3:26982 (CONF-770504—, pp 43-59)
See Trout, J.J., 3:26954
Villa, F., *See* del Papa, C., 3:27102
Vincent, R., *See* Bellus, F., 3:25842
Vine, J.D., New energy-related uses for lithium encourages search for new sources, 3:27020
Vinnikov, L.I., *See* Mukhlenov, I.P., 3:26668
Vinogradov, A.V., *See* Aglitskii, E.V., 3:27692
Vinson, R.P., Methane accumulations in coal mine roof cavities, 3:25691 (BM-RI—8267)
Vinz, P., Fuel rod for liquid metal-cooled nuclear reactors, 3:26329
Vishnevetskii, V.N., *See* Amelin, V.Z., 3:27606
Vlases, G.C., *See* Krakowski, R.A., 3:27454
Volkov, G.G., Possible mechanism of direct production of leptons in pN collisions, 3:27237
Volkov, T.F., Stationary temperature profile in a tokamak reactor operated in the neoclassical regime, 3:27518
Volokitin, A.S., *See* Al'terkop, B.A., 3:27585
Von Goeler, S., *See* Sauthoff, N.R., 3:27469
Von Halle, E.S., *See* Brown, M.M., 3:26994
Vorob'ev, S.A., *See* Abakumov, G.A., 3:26758
Vortanov, Y.A., *See* Abramyan, L.O., 3:27105
Vossoughi, S., Pressure drop and flow distribution of a polymer solution in a non-homogeneous porous medium, 3:25752
Voth, R.O., Studies of hydrogen liquefier efficiency and the recovery of the liquefaction energy, 3:25957 (PB—274058)
Votta, L., *See* Halliwell, C., 3:27124
Voyvodic, L., *See* Raja, R., 3:27128
See Whitmore, J., 3:27139
Vrancken, P.L.L., Twelve years operating experience with Methane Princess and Methane Progress, 3:25876
Vuillemin, V., *See* Scharre, D.L., 3:27113
Vukolova, A.A., *See* Aizen, Kh.K., 3:26165
Vulcan, W.F., *See* Roberson, P., 3:27130
Vyshkind, S.Ya., Phase stochastization mechanism and wave turbulence structure in dissipative media, 3:27587

W

Wachowska, H., Effect of cleavage of ether linkages on physicochemical properties of coals, 3:25672
Wadlinger, E.A., *See* Comiso, J.C., 3:27333
See McCarthy, J., 3:27320
Wagner, S., *See* Shay, J.L., 3:26002
Wagner, U., *See* Peters, K.A., 3:26449
Waibel, R.T., Development of combustion data to utilize low-Btu gases as industrial process fuels. Project 8985 monthly status report, November 1—November 30, 1977, 3:25712 (FE—2489-18)
Waisman, J.L., *See* Gilles, A., 3:25880
Waite, D.A., *See* Oscarson, E.E., 3:26989
Wakatani, M., *See* Matsuoka, K., 3:27559
Waldenmeier, G., *See* Hempelmann, W., 3:25924
Walker, B.G., *See* Dean, N.R., 3:26815
Walker, P.L. Jr., *See* Kamishita, M., 3:25666
Walker, R., *See* Whitmore, J., 3:27139
Walker, W.D., *See* Biswas, N.N., 3:27132
Wallace, A., *See* Romney, E.M., 3:26913
Wallace, S.J., Relativistic eikonal expansion, 3:27153
Waller, R.A., *See* Lohrding, R.K., 3:26505
Wallin, C.C., *See* Vasalos, I.A., 3:25659
Walther, H., *See* Rothe, K.W., 3:26870
Waltz, R.E., Tokamak boundary in contact with a limiter, 3:27630
Walz, H.V., CC80-A microcomputer crate controller for CAMAC, 3:26842 (SLAC-PUB—1840)
Wang, C.L., Empirical formula for inclusive proton spectra between 10 and 300 GeV, 3:27232
Wang, C.S., Electromagnetic modes of heterojunction injection lasers, 3:26764
Wang, J.Y., *See* Hamlin, D.A., 3:27039, 3:27040
Wang, L.C., *See* del Papa, C., 3:27102
Wangler, T., *See* Barish, S.J., 3:27116
Warburton, E.K., High-spin states in A ≅ 40 nuclei: Data for ^{38}Ar and ^{39}K, 3:27346
Ward, B.F.L., Differential dispersive analysis of e^+e^- annihilation into hadrons, 3:27180

Violations of dimensional analysis in renormalized perturbation theory, 3:27282
See Bartlett, D.F., 3:27150
Ward, C.E.W., Cross sections and polarizations in the reactions $\pi^- p \rightarrow \Lambda K^0$ and $\pi^- p \rightarrow \Lambda K^{*0}(890)$ near the backward direction, from 3 to 6 GeV/c, 3:27142
Ward, D.R., *See* Raja, R., 3:27128
Ward, M.E., Development of a ceramic tube heat exchanger with relaxing joint. Quarterly technical progress report, July—October 1, 1977, 3:26152 (FE—2556-09)
Ware, J.W., *See* Carlin, J.T., 3:25747
Warmack, R.J., Ionizing collisions of cesium and potassium atoms with water, 3:27066
Warzawa, W., *See* Huschka, H., 3:26270
Washimi, H., *See* Karpman, V.I., 3:27580
Wassom, J.S., *See* Brown, M.M., 3:26994
Watanabe, E., Prototype tank test of semi-membrane LNG carrier, 3:25878
Watanabe, H., Irradiation experiments of uranium carbide, carbonitride, and nitride fuels in JAERI, 3:26311
Watanabe, K., *See* Suzuki, K., 3:25834
Watrous, R.M., *See* Keister, P.L., 3:26666
Watson, B.A., *See* Fisher, T.R., 3:27375
Watson, C.J.H., *See* Hastie, R.J., 3:27558
Watson, C.R. Jr., *See* Stang, P.J., 3:26685
Watson, E.C., *See* Baker, D.A., 3:26992
See Brenchley, D.L., 3:26873, 3:26874
Watson, F.V., Two-group diffusion calculation through pseudo-continuous synthesis, 3:26352
Watson, G.K., *See* Stephens, J.R., 3:26578
Watson, I., Measurement techniques for AGR circulators in a full-density rig, 3:26265
Watson, J., *See* Murphy, B., 3:26193
Watson, J.M., *See* Lindquist, J., 3:27117
Watt, T.M., Hiris experiment-Chatanika radar results. Topical report, January—December 1976, 3:27032 (AD-A—042183)
Weatherford, W.D. Jr, Corrective action program for bromochloromethane-containing fire-safe diesel fuel. Final report, 3:26590 (AD-A—043323)
Weaver, C.E., Fine-grained sheet silicate rocks, 3:25940 (Y/OWI/SUB—7009/4)
Weaver, L.A., *See* Liu, C.S., 3:26723
Webb, D.V., *See* Euteneuer, H., 3:27343
Weber, D., *See* Pocrnja, A., 3:25839
Weber, P., Dry cooling towers: the Schmehausen example, 3:26263
Weber, W.H., *See* Lewis, H.E., 3:25648
Wecksung, M.J., GMAPS user's manual, 3:26917 (LA—6975-M)
Weeks, R.W. Jr., *See* Morales, R., 3:26997
Weertman, J., Heat extraction from hot, dry rock masses. Progress report, 1 August 1976—31 January 1977, 3:26106 (PB—271411)
Wehr, J., Civil engineering construction in conventional thermal power stations and nuclear power stations, 3:26204
Wei, C.Y., Novel Faraday cup for the simultaneous observation and measurement of ion-beam currents, 3:27055 (COO—3158-55)
Weinberg, E.J., *See* Bernard, C.W., 3:27242
Weingarten, D.H., *See* Stump, D.R., 3:27160
Weiss, N., *See* Brodsky, S.J., 3:27159
Welday, E., *See* Oldson, J., 3:26094
Wellborn, R.E., Structural style in relation to oil and gas exploration in North Park-Middle Park basin, Colorado, 3:25730
Wells, J.A., *See* Carlin, J.T., 3:25747
Wells, J.C. Jr., High-spin states in ^{64}Zn, 3:27357
See Robinson, R.L., 3:27358
Welsh, R.E., *See* Roberson, P., 3:27130
Wentworth, D.E., *See* Jones, W.A., 3:27671
Wentworth, R.L., *See* Ashare, E., 3:26019
Werbin, H., Photorepair of uv damage to DNA: purification and properties of DNA photolyase (the DNA-photoreactivating enzyme). Progress and final reports, August 1, 1976—July 31, 1977, 3:26948 (ORO—3630-26)
Werner, R., *See* Hartman, C.W., 3:27604
Wesley, D.A., Status of the General Atomic HTGR core seismic verification program, 3:26434 (GA-A—14592)
Wesson, J.A., *See* Papaloizou, J.C.B., 3:27525
Westbrook, C.K., *See* Haselman, L.C., 3:26588
Weygand, D.P., *See* Briefel, E., 3:27140
Wharton, J.C., *See* Levine, M.D., 3:26516
Wheeler, C.B., Space charge limited current flow between concentric spheres at potentials up to 15 MV, 3:27684
White, C.M., Avifaunal investigations, 3:26903 (TID—26712, pp 227-260)
Polychlorinated biphenyls in the ecosystems, 3:26906 (TID—26712, pp 615-625)
White, M.D., *See* Clemons, V.D., 3:26440
White, M.G., Environmental plutonium on the Nevada Test Site and environs, 3:26909 (NVO—171)
White, N.A., Cost of energy over the next decade, 3:26499
White, R.B., Simulation of large magnetic islands: A possible mechanism for a major tokamak disruption, 3:27644
Whitmore, J., Comparison of inclusive charged-pion production in π^{+-} p interactions at 100 GeV/c, 3:27139
See Raja, R., 3:27128
Whitney, R.R., *See* McCarthy, J., 3:27318, 3:27319, 3:27377
See McCarthy, J.S., 3:27321
Whittier, J.S., *See* Kerber, R.L., 3:26728
Widart, J., *See* Martin, A., 3:26238
Wiebel, F.J., *See* Selkirk, J.K., 3:26995
Wiedemann, H., Present and future colliding beam facilities at SLAC, 3:26813 (SLAC-PUB—1971)
Wiegandt, K.E., User/programmer guide for UCMD 47: thin film resistor layout, 3:26775 (SAND—77-2035)
Wiesenfeld, J.R., Molecular and chemical laser systems. Final report, 4 February 1974—30 June 1977, 3:26729 (AD-A—043339)
Wiesmann, H., Estimate of density-of-states changes with disorder in A-15 superconductors, 3:26602
Wilcock, D.F., *See* Pinkus, O., 3:26706
Wilcox, D.P., Environmental report No. 22, January—June 1977, 3:26889 (NP—22643)
Wilcox, J.M., *See* Duvall, T.L. Jr, 3:27025
Wilczek, F., Geometry and interactions of instantons, 3:27182
Instantons and spin forces between massive quarks, 3:27256
Wilczynski, J., *See* Hrynkiewicz, A., 3:27316
Wilde, P., *See* Oldson, J., 3:26094
Wiley, R.A., *See* Benkovitz, C.M., 3:27717
See Wecksung, M.J., 3:26917
Wilke, C.R., Cellulose, food and energy, 3:26021 (LBL—5275)
See Batter, T.R., 3:26022
Wilke, N., *See* Sitt, B., 3:27667
Wilkinson, L.E., Western States energy resource development update 1976, 3:26503
Wille, H., Plant engineering experience with primary water purification plants in nuclear power stations with pressurised and boiling water reactors, 3:26216
Williams, A., *See* Jordan, J.B., 3:25718
Williams, E.A., *See* Albritton, J.R., 3:27683
Williams, G.L., *See* Jansa, L.F., 3:25743
Williams, J.M., Single crystal neutron diffraction studies of partially oxidized $K_2Pt(CN)_4Br_{0.3}.3.0H_2O$, $K_2Pt(CN)_4Cl_{0.3}.3.0H_2O$, and $K_{1.75}Pt(CN)_4.1.5H_2O$: new results and a summary, 3:26682
Williams, S.H., *See* Gilchriese, M.G.D., 3:27138
Williamson, F.S.L., *See* White, C.M., 3:26903
Williamson, H.E., Fuel element assembly, 3:26223
Williamson, H.J., Analysis of random errors in air-quality measurements. Final report, 3:26881 (PB—270555)
Willis, D.E., *See* Taylor, R.W., 3:26861
Wills, J.G., *See* Lichtenberg, D.B., 3:27185
Willson, W.G., *See* Knell, E.W., 3:25654
Wilmore, D., *See* Bellamy, R.G., 3:26317
Wilson, C., *See* Miller, D., 3:27131
Wilson, J.R., *See* Burdick, G.R., 3:26221
Wilson, J.V., *See* Anderson, T.D., 3:26032
Wilson, J.W., Foil shielded flexible conduit, 3:26364
Wilson, P.B., *See* Allen, M.A., 3:26812
Wilson, R., Occupational doses in the Ontario Hydro nuclear power program, 3:26463
Wilson, R.E., *See* Braunschweig, E.D., 3:26753
Wilson, R.R., *See* Watson, I., 3:26265
Wilson, W., *See* Anderson, O.L., 3:26111
Windingland, L.M., Market evaluation study: solar heating and domestic hot water heating in DOD buildings. Final report, 3:26042 (AD-A—042178)
Winfrey, J.H., Computer study of many waves in the small cold beam and plasma interaction, 3:27578
Winge, R.K., Determination of trace elements in soft, hard, and saline waters by the inductively coupled plasma, multi-element atomic emission spectroscopic (ICP-MAES) technique, 3:26664
Winje, D., Growth and adaptation processes in the power industry of the Federal Republic of Germany. A simulation model, 3:26526
Winkler, A.K., *See* Verolme, C., 3:25877
Winslow, G., *See* Finn, P.A., 3:26633
Winsor, N., *See* Papadopoulos, K., 3:27524
Winston, R., *See* Lindquist, J., 3:27117
Winter, N., *See* Rescigno, T.N., 3:27073
Winterberg, F., Ablation driven thermonuclear implosion targets of high efficiency, 3:27687
Wise, D.L., *See* Ashare, E., 3:26019
Wisniewski, H.L., Coupling of x-ray deposition to structural response. Final report, 3:27398 (AD-A—042667)
Witzke, W.R., *See* Stephens, J.R., 3:26578
Wolcott, J.H., Characteristics of late-time striations observed during operation stress, 3:27044 (LA-UR—77-2835)
Wolf, G., *See* Alekseevskii, N.E., 3:26655
Wolfe, D.M., *See* Lindquist, J., 3:27117
Wolfe, J.P., *See* Jeffries, C.D., 3:26646
Wolff, P.M., Ocean thermal energy conversion: resource, ecological and environmental studies. Final technical report, 3:26041 (PB—269283)
Wolfsberg, M., *See* DeFrees, D.J., 3:26691
Wolga, G.J., *See* Wiesenfeld, J.R., 3:26729
Wolsky, G., *See* Briefel, E., 3:27140
Wong, C., *See* Fitzgerald, D.H., 3:27365
Wong, N.C., Multiphoton absorption in the presence of two finite-bandwidth lasers, 3:27051
Wong, S.K., Modification of Pfirsch—Schlueter transport by poloidally asymmetric sources, 3:27512
See Prater, R., 3:27543
Wonnell, L.D., Universal monitor for CO_2 lasers, 3:26736 (BDX—613-1907)

Woo, J.T., Neutral-injection-induced transport in mirror-confined plasmas, 3:27464
Wood, R.E., *See* Palms, J.M., 3:27056
Woodard, J.B., STEAEC: Solar Thermal Electric Annual Energy Calculator documentation, 3:26033 (SAND—77-8278)
Woodin, R.L., Binding of Li^+ to Lewis bases in the gas phase. Reversals in methyl substituent effects for different reference acids, 3:26673
Woodland, L.R., *See* LaMantia, C.R., 3:25678
Woodley, R.E., US—UK technical exchange breeder reactor fuels: fuel pin chemistry, 3:26282 (HEDL—6297)
Woodruff, G.L., *See* Krakowski, R.A., 3:27454
Woods, J.W., *See* Ekstrom, M.P., 3:27711
Woody, C., *See* Gilchriese, M.G.D., 3:27138
Woolson, W.A., *See* Huszar, L., 3:27400
Worsnop, P.A., THOR tokamak engineering design and experimental programme, 3:27596 (EUR—5602, pp 281-286)
Wouters, J.M., *See* Cerny, J., 3:26803
Wright, A.E., *See* Deitrich, L.W., 3:26431
Wright, B.R., *See* Weatherford, W.D. Jr, 3:26590
Wright, I.G., *See* Mueller, J.J., 3:25647
Wright, M.D., Study of crisis utilization of large shelter space. Final report, 3:26712 (AD-A—046061)
Wright, S.A., *See* McDaniel, P.J., 3:26358
Wrona, B.J., Experimental study of advanced fuel-pin failure phenomena, 3:26313
Wu, C.S., *See* Davidson, R.C., 3:27549
Wu, J.R., Pre-equilibrium particle decay in the photonuclear reactions, 3:27327
Wu, M.S., *See* Lee, K.C., 3:25677
Wyler, D., Flavor conservation in an SU(3) x U(1) x U(1) model, 3:27198

Y

Yaakobi, B., Direct measurement of compression of laser-imploded targets using x-ray spectroscopy, 3:27474
Yagi, N., *See* Tada, B., 3:25885
Yagnyatinskii, B.V., *See* Egerev, V.V., 3:25972
Yakovlev, Y.P., Fragmentation of nuclei by high-energy particles, 3:27135
Yalova, A.Ya., *See* Shakhsuvarov, K.L.V., 3:26171
Yamada, K., Optimum operating conditions for a laser uranium enrichment plant, 3:25918
Optimum operating conditions for a laser uranium enrichment plant, 3:25919
See Ozaki, N., 3:25920
Yamada, R., Application of finite element method to ring compression test, 3:26387
Yamaguchi, T., Studies on defect occurrence of LPG tank insulation executed in winter, 3:25866
Yamamoto, M., *See* Morishita, O., 3:27702
See Ozaki, N., 3:25920
See Tanaka, S., 3:25867
See Yamada, K., 3:25918, 3:25919
Yamamoto, S., *See* Kimura, H., 3:27467, 3:27613
Yamao, S., *See* Ishihama, W., 3:25676
Yamato, H., *See* Maki, K., 3:27432
Yamazaki, H., *See* Kadota, K., 3:27657
Yamazaki, K., *See* Inoue, N., 3:27453
Yamazaki, Y., *See* Motojima, K., 3:25931
Yamin, P., *See* Heller, K., 3:27129
Yan, T.M., Charmonium, 3:27163
Yanaida, K., Studies on the flow characteristics of high speed water jets in air: the breakup characteristics of the water jet atomizer (2nd report), 3:25696
Yang, C.I., *See* Billone, M.C., 3:26318
See Madell, J.T., 3:26324
Yang, R.T., Regeneration of lime-based sorbents in a kiln with solid reductants, 3:25710 (BNL—23765)
Yang, T.F., Compact poloidal divertor reference design for TNS, 3:27621 (WFPS-TME—055)
Yanichkin, L.P., *See* Kadyrova, G.I., 3:25775
Yanturin, A.Sh., Spiral deformation of a pipe string in a directional well, 3:25754
Yanu, A.Yu., *See* Minsker, K.S., 3:25776
Yao, N.P., *See* Landgrebe, A.R., 3:26485
See Nelson, P.A., 3:26486
Yao, Y., *See* Chang, S., 3:27152, 3:27155
Yashiro, M., *See* Tominaga, H., 3:25899
Yates, A.L., *See* Burd, W.C., 3:27708
Yates, J.T., *See* Zuclich, J.A., 3:26999
Yates, J.T. Jr, *See* Madey, T.E., 3:25968
Yates, M.A., *See* Jackson, H.E., 3:27323
Yates-Williams, M.A., *See* Bowles, T., 3:27334
See Gram, P.A.M., 3:27058
Yellott, J.I., ASHRAE'S approach to solar collector test standards, 3:26074
Yen, T.F., *See* Young, D.K., 3:25891
Yenyakin, Yu.P., *See* Krutiev, V.A., 3:26195
Yerushalmi, J., *See* Graff, R.A., 3:25635
Yesavage, V.F., *See* Kidnay, A.J., 3:25652
Yie, G.G., Performance of a high-pressure pulsed water-jet device for fracturing concrete pavement, 3:26704 (CONF-780409—1)
Yodh, G.B., *See* Briefel, E., 3:27140
Yokosawa, A., *See* Miller, D., 3:27131
Yokota, M., *See* Fukui, K., 3:25809
Yonekura, I., *See* Murata, Y., 3:25868
Yoon, T.S., *See* Biswas, N.N., 3:27132
York, S.B. III, *See* Wright, M.D., 3:26712
Yoshinaga, K., *See* Ohkubo, K., 3:26688
Yost, G.P., *See* Ballagh, H.C., 3:27114
Young, C., *See* Halliwell, C., 3:27124
Young, D.K., Nature of straight-chain aliphatic structures in Green River kerogen, 3:25891
Young, J.P., *See* Hurst, G.S., 3:27062
Young, L.Y., *See* Healy, J., 3:26007
Young, P.G., *See* Veeser, L.R., 3:27353
Young, R.T., Future of nuclear propulsion in merchant ships, 3:26429
Young, T.K., *See* Davis, T.L., 3:25733
Young, W.C., *See* Michaelson, P.F., 3:27640
Yount, D.E., *See* Scharre, D.L., 3:27113
Yovanovitch, D.D., *See* Ward, C.E.W., 3:27142
Yuan, L.C.L., *See* Amaldi, E., 3:27133
Yudaev, A.I., *See* Minsker, K.S., 3:25776
Yudintsev, E.M., *See* Zakharov, A.S., 3:26750
Yuferov, V.B., *See* Lesnyakov, G.G., 3:27698
Yukov, E.A., *See* Aglitskii, E.V., 3:27692
Yuldashev, B.S., *See* Ballagh, H.C., 3:27114
Yunn, B.C., *See* Kupsch, J., 3:27304
Yur'ev, L.V., *See* Shnitser, I.N., 3:26157
Yurchak, R.P., *See* Aivazov, A.A., 3:26614
Yusufzade, A.A., *See* Sitaraman, P.D., 3:25770
Yuta, H., *See* Barish, S.J., 3:27116
See Derrick, M., 3:27125
See Ward, C.E.W., 3:27142

Z

Zaalouk, M.G., *See* Peterson, W.C., 3:26348
Zabiyakin, Yu.E., Dye-based laser with high directionality of radiation, 3:26766
Zabortseva, T.A., Influence of resonant properties of the discharge of He—Ne laser emission, 3:26751
Zaidins, C.S., Least-squares technique for extracting neutron spectra from Bonner sphere data, 3:26828
Zakhar'ev, B.N., Inverse scattering problem (finite-difference approach), 3:27311
Zakharenkov, Yu.A., *See* Basov, N.G., 3:27689
Zakharov, A.S., Pulsed electrical-discharge CO_2 laser with ionization of the gas mixture by ultraviolet radiation at atmospheric pressure, 3:26750
Zakharov, V.E., *See* Belavin, A.A., 3:27285
Zakharov, V.P., *See* Abakumov, G.A., 3:26758
Zar, J.L., Temperature, stress and optical phase difference for a window transmitting a cw laser beam. Research report, 3:26726 (AD-A—042671)
Zarnecki, J.C., X-ray spectrum and structure of the Puppis a supernova remnant, 3:27030
Zavgorodnii, V.A., *See* Andreev, M.F., 3:27385
Zavgorodnya, O.V., Possible field variant for determining the earth heat flow by the method of temperature waves reduction (TWR), 3:26098
Zborovskii, I.D., *See* Litovskii, E.Y., 3:26642
Zdanis, R.A., *See* Gilchriese, M.G.D., 3:27138
Zdanovich, N.N., Experimental investigation of heat transfer in a once-through regenerator-evaporator with a chemically reacting coolant, 3:26383
Zee, A., *See* Wilczek, F., 3:27256
Zehrfeld, H.P., *See* Green, B.J., 3:27557
Zeidler, E., Some recent results in bifurcation theory, 3:27421
Zeidman, B., *See* Geesaman, D.F., 3:27350
Zeigarnik, V.A., *See* Dikhter, I.Y., 3:27492
Zeiger, E.M., *See* Karlsson, B.R., 3:27310
Zeinalov, F.I., *See* Melik-Akhnazarov, T.Kh., 3:25778
Zelenov, A.A., *See* Zakharov, A.S., 3:26750
Zelentsova, N.I., *See* Taber, A.M., 3:25792
Zenkevich, V.B., SPMS-1 superconducting magnet system for an MHD generator, 3:26539 (JPRS—69811)
Zerna, W., Possible cooling tower designs and their economy, 3:26136
Zganjar, E.F., *See* Cole, J.D., 3:27370
Zharkov, B.B., *See* Maslyanskii, G.N., 3:25772
Zhdanov, S.K., *See* Vikhrev, V.V., 3:27517
Zhelnin, V.A., *See* Bityurin, V.A., 3:26537
Zherebtsov, V.A., *See* Gus'kov, Yu.K., 3:26541
Zhmakin, L.I., *See* Shpil'rain, E.E., 3:26639
Zhukov, A.P., *See* Burtsev, V.A., 3:27460
Zhuravlev, B.V., *See* Biryukov, N.S., 3:27354
Zhurba, L.A., *See* Tsybulevskii, A.M., 3:25773
Ziegler, A., District heating as a task for government and economy. Existing networks to be extended systematically: special responsibilities for communities, 3:26508
Zimmer, P.B., *See* Lin, R.J.H., 3:26060
Zimmerman, G., *See* Harte, J., 3:27093
Zimmerman, W.R., $^{56}Fe(^3He,t)^{56}Co$ reaction, 3:27349

Zinger, N.M., Hydraulic design of a branched heating network, employing an electronic digital computer, 3:26547
Zinov'ev, V.E., *See* Korshunov, I.G., 3:26615
Ziock, H.J., *See* Comiso, J.C., 3:27333
Ziock, K.O.H., *See* Comiso, J.C., 3:27333
See McCarthy, J.S., 3:27097
Ziock, K.P., *See* Comiso, J.C., 3:27333
Ziskand, G.A., *See* Livshits, M.A., 3:26176
Zisman, M., *See* Kovar, D.G., 3:27351
Zisman, M.S., *See* Cerny, J., 3:26803
See Miller, J.M., 3:27379
Zorev, N.N., *See* Basov, N.G., 3:27689
Zuclich, J.A., Research on the ocular effects of laser radiation. Final report, 16 February 1975—30 November 1976, 3:26999 (AD-A—043457)
Zumino, B., Supersymmetry, 3:27297
Zvitra, Z.V., *See* Mullaney, P.F., 3:26961

SUBJECT INDEX

The subject index is based on the use of subject descriptors selected from a controlled thesaurus of terms. Subject descriptors and qualifiers (subheadings) are selected and presented in the following format:

SUBJECT DESCRIPTOR/QUALIFIER
Title, (supplementary information), citation number, (report number)

The title may be supplemented with additional words, or a phrase, if it appears additional information would be helpful. In cases for which the title contains little or no information related to the subject entry, it may be replaced entirely by the supplementary information. A qualifier is not always required, and in such cases the title will follow the unqualified subject descriptor.

The descriptors selected for use as subject terms are generally the names of specific materials, things, or processes. To the extent possible, a qualifier is selected to describe the properties of, or processses applied to, the subject term.

Index entries are selected to indicate the important ideas and concepts presented in a document, rather than words that may appear in the text. Within the available thesaurus terms, the most probable or logical place to look for typical information is selected. "See references" are included to guide users from synonymous terms or phrases to the descriptor selected as a subject heading for the concept. (e.g. Pipeline Quality Gas see HIGH BTU GAS). "See also references" are used to indicate where to find references to subject concepts that are narrower, broader, or related to a particular subject heading. To complete an exhaustive search of a given subject, all such headings should be reviewed.

A

A-1 REACTOR (CALDER HALL)
See CALDER HALL A-1 REACTOR

AC SYSTEMS
See also EHV AC SYSTEMS

AC SYSTEMS/ENVIRONMENTAL IMPACTS
Alternative electrical transmission systems and their environmental impact, 3:26200 (PB-271652)

ACCELERATORS
See also CYCLOTRONS
DYNAMITRONS
LINEAR ACCELERATORS
ORNL ISOCHRONOUS CYCLOTRON
STORAGE RINGS
VAN DE GRAAFF ACCELERATORS
Conserving uranium without the fast breeder, 3:26506

ACCELERATORS/SHIELDING
Similarities among the radiation fields at different types of high energy accelerators, 3:26796 (SLAC-PUB-1805)

ACCIDENTS
See also RADIATION ACCIDENTS
REACTOR ACCIDENTS

ACCIDENTS/ENVIRONMENTAL EFFECTS
Detailed accident analysis for the high level waste preparation phase of the commercial nuclear waste vitrification project, 3:26989 (BNWL-2207)

ACES
See QUARKS

ACETONE/MOLECULE-MOLECULE COLLISIONS
Energy transfer cross sections in relation to generalized oscillator strengths for the donor-acceptor pair benzene-acetone, 3:27065

ACETYLENES
See ALKYNES

ACHOLEPLASMA LAIDLAWII B/BIOLOGICAL RADIATION EFFECTS
Characterization of an enveloped mycoplasmavirus (Ultraviolet radiation), 3:26977 (UR-3490/LCP-4)

ACID ELECTROLYTE FUEL CELLS/RESEARCH PROGRAMS
Advanced technology fuel cell program. Interim report, 3:26543 (EPRI-EM-576)

ACID MINE DRAINAGE/BIBLIOGRAPHIES
Acid mine drainage (a bibliography with abstracts). Report for 1964-Nov 77, 3:26931 (NTIS/PS-77/0949)

ACOUSTIC TESTING/WAVE PROPAGATION
Iterative reconstruction of underground refractive index distributions from cross-borehole transmission data, 3:27006 (UCRL-52348)

ACPR REACTOR/MODIFICATIONS
Annular core pulse reactor upgrade. Quarterly report, July-September 1977, 3:26424 (SAND-77-1807)

ACRYLIC POLYMERS
See POLYACRYLATES

ACTINIDE NUCLEI/BINARY FISSION
Rupture of the neck in nuclear fission, 3:27380

ACTINIDES/ION EXCHANGE
Cation exchange of 53 elements in nitric acid, 3:26665 (LA-7083)

ACTIVATED CARBON
Enhancement of methane production with activated carbon, 3:26012 (COO/2991-19)

ACTIVATION DETECTORS/SENSITIVITY
High energy photon response of moderated neutron detectors (Polyethylene-moderated indium activation foil with cadmium filter), 3:26820 (SLAC-PUB-1768)

ADENOCARCINOMAS
See CARCINOMAS

ADIABATIC TOROIDAL COMPRESSORS
See ATC DEVICES

ADSORBENTS/COMPARATIVE EVALUATIONS
Preparation of a coal conversion systems technical data book. Project 8979 monthly status report, November 1-November 30, 1977, 3:25615 (FE-2286-25)

ADSORBENTS/REGENERATION
Preparation of a coal conversion systems technical data book. Project 8979 monthly status report, November 1-November 30, 1977, 3:25615 (FE-2286-25)
Regeneration of lime-based sorbents in a kiln with solid reductants, 3:25710 (BNL-23765)

ADVANCED GAS COOLED GRAPHITE REACTOR
See AGR TYPE REACTORS

AEGEAN SEA/HEAT FLOW
Comparison and interpretation of borehole and marine heatflow data from the Mediterranean and Aegean Seas (abstract), 3:26109

AEROSOLS
See also RADIOACTIVE AEROSOLS

AEROSOLS/AIR POLLUTION MONITORS
Study of aerosol assessment instrumentation. Final report Jun-Oct 76, 3:26869 (AD-A-046052)

AEROSOLS/DIFFUSION
Wind effected redistribution of surface contamination. Final report, September 1972-August 1976, 3:26880 (ORO-4394-4)

AEROSOLS/PARTICLE SIZE
Chemical composition of sulfate as a function of particle size in New York summer aerosol, 3:26872 (BNL-23672)

AEROSOLS/SAMPLING
Development of sampling and analytical methods for carcinogens. Progress report, January 1-September 30, 1976, 3:26997 (LA-7058-PR)

AGEDOITE
See ASPARAGINE

AGGLOMERATING ASH PROCESS/EFFICIENCY
Modification and operation of the atmospheric ash-agglomerating gasifier on coal. Project 9020 monthly progress report, October 1977, 3:25634 (FE-2336-17)
AGGLOMERATING ASH PROCESS/PILOT PLANTS
Modification and operation of the atmospheric ash-agglomerating gasifier on coal. Project 9020 monthly progress report, October 1977, 3:25634 (FE-2336-17)
AGR TYPE REACTORS
Advanced gas-cooled reactor has good energy prospects, 3:26256
AGR TYPE REACTORS/COMPRESSORS
Measurement techniques for AGR circulators in a full-density rig, 3:26265
AGRICULTURAL WASTES/ACID HYDROLYSIS
Study of the fermentation of xylose to ethanol by fusarium oxysporum, 3:26022 (LBL-6351)
AGRICULTURAL WASTES/ANAEROBIC DIGESTION
Anaerobic fermentation of animal and crop residues: summary. Quarterly progress report (second), April 1, 1977-June 10, 1977, 3:26017 (COO/2991-19)
Energy relationships for a 320-acre Iowa farm: an attempt to increase production of grain and meat while rendering the farm energy self-sufficient by generating methane through anaerobic fermentation of residues, 3:26020 (ERDA/USDA-19464/76/FR-3)
AGRICULTURAL WASTES/PHYSICAL PROPERTIES
Anaerobic fermentation of animal and crop residues: summary. Quarterly progress report (second), April 1, 1977-June 10, 1977, 3:26017 (COO/2991-19)
AGRICULTURE/ENERGY CONSUMPTION
Energy use in the dairy industry (report No. 25), 3:26529 (NP-23050)
Energy use in agriculture: now and for the future, 3:26530
AGRICULTURE/WASTE HEAT UTILIZATION
Agricultural use of heat discharge by nuclear power plants, 3:26420
AIR
See also EARTH ATMOSPHERE
AIR/CONTAMINATION
Radionuclides in air, water, and biota (^{40}K, ^{7}Be, ^{137}Cs), 3:26934 (TID-26712)
AIR/NEUTRON TRANSPORT
Energy dependent air/ground correction factors for the ATR (air transport of radiation) code. Final report, 3:27400 (AD-A-043807)
AIR/PARTICLES
Comparison of aerosol and momentum mixing in dust storms using fast-response instruments, 3:26866
AIR/PHOTON TRANSPORT
Energy dependent air/ground correction factors for the ATR (air transport of radiation) code. Final report, 3:27400 (AD-A-043807)
AIR/POLLUTION
Environmental effect of mercury, with particular attention to the Monte Amiata Zone, 3:26885 (ORNL-tr-4479)
AIR/X-RAY FLUORESCENCE ANALYSIS
Automated elemental analysis using energy dispersive x-ray fluorescence analysis, 3:26879 (LBL-7211)
AIR CONDITIONERS
See also SOLAR AIR CONDITIONERS
AIR CONDITIONERS/HEAT RECOVERY
Matrix rotor fan combines heat recovery with balanced ventilation, 3:26550
AIR CONDITIONING
See also SOLAR AIR CONDITIONING
AIR CONDITIONING/CONTAINERS
Instructions for treating internal coatings of man-sized pipes and containers, 3:26552
AIR CONDITIONING/PIPES
Instructions for treating internal coatings of man-sized pipes and containers, 3:26552
AIR FILTERS/CLEANING
Panel bed filter. Final report, 3:25677 (EPRI-AF-560)
AIR FILTERS/PERFORMANCE TESTING
Long term performance of charcoal absorbers removing radioiodine in ventilation exhaust air. Final report, 3:26356 (EPRI-NP-534)
AIR HEATERS/CORROSION
Investigation of contamination and corrosion of regenerative air preheaters during combustion of Ekibastuz coal, 3:26166
AIR HEATERS/DESIGN
Air preheater made of corrugated tubes, 3:26168
AIR HEATERS/SIMULATION
Testing and evaluation of MHD materials and substructures. Quarterly technical progress report, January-March 1977, 3:26538 (FE-2246-3(Rev.A))
AIR POLLUTION/AERIAL MONITORING
Aquatic and terrestrial surveys in the vicinity of power plants using remote sensing. Final report, 3:26920 (PB-273463)
AIR POLLUTION/ECOLOGICAL CONCENTRATION
Estimation of air concentrations due to the diffusion, deposition and resuspension of contaminants by the wind, 3:26883 (PNL-2426)
AIR POLLUTION/ENVIRONMENTAL TRANSPORT
PATRIC: a three dimensional particle-in-cell sequential puff code for modeling the transport and diffusion of atmospheric pollutants, 3:26884 (UCID-17701)
AIR POLLUTION/FORECASTING
Estimation of air concentrations due to the diffusion, deposition and resuspension of contaminants by the wind, 3:26883 (PNL-2426)
AIR POLLUTION/MATHEMATICAL MODELS
Estimation of air concentrations due to the diffusion, deposition and resuspension of contaminants by the wind, 3:26883 (PNL-2426)
New measure of association for spatial variables. Technical report No. 7, 3:26876 (COO-2874-16)
PATRIC: a three dimensional particle-in-cell sequential puff code for modeling the transport and diffusion of atmospheric pollutants, 3:26884 (UCID-17701)
AIR POLLUTION/PARTICLE RESUSPENSION
Wind effected redistribution of surface contamination. Final report, September 1972-August 1976, 3:26880 (ORO-4394-4)
AIR POLLUTION CONTROL/EMERGENCY PLAN
Cost/effectiveness analysis of the Illinois ozone episode regulation (R75-4). Final Report, 3:26890 (PB-270896)
AIR POLLUTION MONITORS/TECHNOLOGY ASSESSMENT
Study of aerosol assessment instrumentation. Final report Jun-Oct 76, 3:26869 (AD-A-046052)
AIR QUALITY/DATA ANALYSIS
Analysis of random errors in air-quality measurements. Final report, 3:26881 (PB-270555)
ALASKA/ENERGY SOURCE DEVELOPMENT
Western States energy resource development update 1976, 3:26503
ALASKA/EXPLORATION
Previous scientific investigations, 1867-1967, 3:26899 (TID-26712)
ALASKA/GEOCHEMICAL SURVEYS
Geochemical dispersion at the Mother Lode Mine near Kennicott, Alaska, 3:27015 (LA-6987-MS)
ALASKA OIL PIPELINE/ELECTRIC CURRENTS
Study of the magnetic field annihilation process in the magnetosphere and some applications (electric currents in the Trans-Alaska pipeline induced by auroral activity), 3:27045 (RLO/2229/T5-7)
ALASKA OIL PIPELINE/ENVIRONMENTAL EFFECTS
Alaskan oil transportation issues, 3:25801 (EPA-600/9-77-019)
ALCATOR DEVICE/CYCLOTRON RADIATION
Electron cyclotron emission in ALCATOR tokamak, 3:27497
ALCATOR DEVICE/IMPURITIES
Observation of poloidal asymmetry in impurity-ion emission due to del B drifts, 3:27446
ALCATOR DEVICE/NEUTRAL-PARTICLE TRANSPORT
Numerical calculations of transport in ALCATOR, 3:27507 (PPPL-1411)
ALCATOR DEVICE/PLASMA DRIFT
Observation of poloidal asymmetry in impurity-ion emission due to del B drifts, 3:27446
ALCOHOLS
See also BUTANOLS
CYCLOHEXANOL
ETHANOL
GLYCOLS
METHANOL
ALCOHOLS/COMBUSTION
Theoretical and experimental investigation of the ignition of fuel droplets, 3:26702
ALCOHOLS/SORPTIVE PROPERTIES
Absorption of ammonia with organic solvents, 3:25969
ALCOHOLS/STEAM REFORMER PROCESSES
Advanced technology fuel cell program. Interim report, 3:26543 (EPRI-EM-576)
ALEUTIAN ISLANDS
See also AMCHITKA ISLAND AREA
ALEUTIAN ISLANDS/ARCHAEOLOGY
Prehistoric human occupation of the Rat Islands, 3:26898 (TID-26712)
ALEUTIAN ISLANDS/EXPLORATION
Previous scientific investigations, 1867-1967, 3:26899 (TID-26712)
ALEUTIAN ISLANDS/FISHING INDUSTRY
Fishery resources of the western Aleutians, 3:26937 (TID-26712)
ALEUTIAN ISLANDS/RESOURCE CONSERVATION
Fishery resources of the western Aleutians, 3:26937 (TID-26712)
ALFVEN WAVES/DAMPING
Phase mixing in the continuous spectrum of Alfven waves, 3:27572
ALFVEN WAVES/EXCITATION
Alfven short-wave excitation by high-energy ions in a tokamak, 3:27562 (IAE-2552)

ALFVEN WAVES/INTERACTIONS
Quasy - linear theory of satellite interaction of alphaparticles with Alfven waves in a tokamak, 3:27564 (IAE-2655)
ALGAE/CELL WALL
Studies on the control of cell wall extension. Progress report, July 1, 1976-September 1, 1977, 3:26949 (RLO/2225/T19-43)
ALGAE/ECOLOGY
Ecology of marine algae (Prasiola, Rhodochorton, Porphyra, Ulothrix, Alaria, Fucus), 3:26925 (TID-26712)
ALGAE/PHOTOSYNTHESIS
Effect of light on respiration and development of photosynthetic cells. Progress report, June 1, 1976-August 31, 1977 (Chlamydomonas, Euglena, spinach, peas), 3:26969 (COO-3231-5)
ALGAE/PRODUCTION
Utilization and disposal of wastes by photosynthetic bacteria, 3:26003
ALKALI METALS
See also CESIUM
LITHIUM
POTASSIUM
SODIUM
ALKALI METALS/ION EXCHANGE
Cation exchange of 53 elements in nitric acid, 3:26665 (LA-7083)
ALKALINE EARTH METALS
See also BARIUM
BERYLLIUM
CALCIUM
ALKALINE EARTH METALS/ION EXCHANGE
Cation exchange of 53 elements in nitric acid, 3:26665 (LA-7083)
ALKANES
See also DODECANE
HEPTANE
METHANE
PENTANE
ALKANES/DEHYDROGENATION
Dehydrogenation of higher paraffins, 3:25793
ALKANES/PRODUCTION
Influence of alcohols on urea-adduct formation with solid paraffins, 3:25779
ALKENES
See also BUTENES
HEXENES
2-METHYLPROPENE
ALKENES/PRODUCTION
Dehydrogenation of higher paraffins, 3:25793
Developments in olefins production technology, 3:25767
ALKYNES/CHEMICAL PROPERTIES
Synthetic methods of using secondary pyrolysis by-products (Piperylene (1,3-pentadiene); methylacetylene), 3:25792
ALLENE/CHEMICAL PROPERTIES
Synthetic methods of using secondary pyrolysis by-products, 3:25792
ALPHA BEAMS/ION-ATOM COLLISIONS
Z^3 effect in the ionization cross section of argon by 1.2- and 2.0-MeV α particles, 3:27401
ALPHA BEAMS/LET
Z^3 effect in the ionization cross section of argon by 1.2- and 2.0-MeV α particles, 3:27401
ALPHA DOSIMETRY/DATA ANALYSIS
Integrated minicomputer alpha analysis system (Measurements of alpha activities of particulates), 3:26888 (LA-UR-77-2968)
ALPHA REACTIONS/COULOMB EXCITATION
Coulomb excitation measurements of reduced E2 and E4 transition matrix elements in ^{156,158}Dy, ^{162,164}Er, and ^{168}Yb, 3:27374
E2 and E4 reduced matrix elements of ^{154,156,158,160}Gd and ^{176,178,180}Hf, 3:27373
ALPHA REACTIONS/ELASTIC SCATTERING
Coulomb excitation measurements of reduced E2 and E4 transition matrix elements in ^{156,158}Dy, ^{162,164}Er, and ^{168}Yb, 3:27374
ALPHA REACTIONS/STRIPPING
Low-lying states in ^{39}Ar from the ^{37}Cl(α,d)^{39}Ar reaction, 3:27345
ALPHA SPECTROMETERS/LIQUID SCINTILLATION DETECTORS
Optimization of the detector and associated electronics used for high-resolution liquid-scintillation alpha spectroscopy, 3:26829
ALTHEIN
See ASPARAGINE
ALUMINATES/FABRICATION
Advanced fuel cell development. Progress report, July-September 1977 (β-$LiAlO_2$ electrolytes), 3:26542 (ANL-77-79)
ALUMINIUM/CHARGED-PARTICLE TRANSPORT
An investigation of 10 to the 12th power w per sq cm focused reb deposition of thick aluminum targets. Interim report, 3:27397 (AD-A-042211)
ALUMINIUM/EMISSION SPECTROSCOPY
Determination of trace elements in soft, hard, and saline waters by the inductively coupled plasma, multi-element atomic emission spectroscopic (ICP-MAES) technique, 3:26664
ALUMINIUM/ION COLLISIONS
Role of K-shell vacancies in determining charge-state fractions for heavy ions emerging from solids, 3:27077
ALUMINIUM/ION EXCHANGE
Cation exchange of 53 elements in nitric acid, 3:26665 (LA-7083)
ALUMINIUM 24/ENERGY LEVELS
Reappraisal of the ^{24}Mg(^{3}He,t)^{24}Al data to low-lying 1^+ states, 3:27339
ALUMINIUM 27 TARGET/NEUTRON REACTIONS
Coherent dissociation of neutrons on nuclei at 100-300 GeV/c, 3:27123
Inclusive charged-particle production in neutron-nucleus collisions, 3:27121
ALUMINIUM 27 TARGET/NITROGEN 14 REACTIONS
High-spin states in A $\cong$ 40 nuclei: Data for ^{38}Ar and ^{39}K, 3:27346
ALUMINIUM 27 TARGET/PHOTONUCLEAR REACTIONS
Pre-equilibrium particle decay in the photonuclear reactions, 3:27327
ALUMINIUM 27 TARGET/PION MINUS REACTIONS
Coincidence measurements of quasielastic pion scattering by ^{27}Al and ^{208}Pb, 3:27342
Energetic charged particle yields induced by pions on complex nuclei (π^{+-} on ^{27}Al, ^{62}Ni, ^{181}Ta, 100 and 220 MeV: cross sections), 3:27360 (ANL-77-60)
Neutron and proton knockout from ^{19}F and ^{27}Al by negative pions, 3:27329
ALUMINIUM 27 TARGET/PION PLUS REACTIONS
Coincidence measurements of quasielastic pion scattering by ^{27}Al and ^{208}Pb, 3:27342
Energetic charged particle yields induced by pions on complex nuclei (π^{+-} on ^{27}Al, ^{62}Ni, ^{181}Ta, 100 and 220 MeV: cross sections), 3:27360 (ANL-77-60)
ALUMINIUM ALLOYS
See also ZIRCALOY
ALUMINIUM ALLOYS/CREEP
Titanium and titanium alloy creep (a bibliography with abstracts). Report for 1964-September 1977, 3:26598 (NTIS/PS-77/0803)
ALUMINIUM ALLOYS/REFLECTIVITY
Thermomodulation spectra of the superconducting alloy $Nb_3(AlSi)$, 3:26626
ALUMINIUM ALLOYS/SUPERCONDUCTIVITY
Thermomodulation spectra of the superconducting alloy $Nb_3(AlSi)$, 3:26626
ALUMINIUM COMPOUNDS/CATALYTIC EFFECTS
Catalytic reforming of naphtha cuts over polymetallic catalysts, 3:25772
Polymerization (oligomerization) of isobutyl from eneommercial c_4 hydrocarbon fraction in the presence of soluble organoaluminum catalysts, 3:25776
ALUMINIUM HYDRIDES/CHEMICAL RADIATION EFFECTS
Effects of γ-ray radiation on the thermal decomposition of lithium aluminum hydride powder, 3:26697
ALUMINIUM HYDRIDES/PYROLYSIS
Effects of γ-ray radiation on the thermal decomposition of lithium aluminum hydride powder, 3:26697
ALUMINIUM IONS/STARK EFFECT
Stark profile measurements on Lyman series lines of Al XIII, 3:27471
ALUMINIUM OXIDES/CATALYTIC EFFECTS
Hydrogenation of hexene over platinum on alumina vs. platinum in a Na-Y zeolite, 3:26684
ALUMINIUM OXIDES/EMISSIVITY
Infrared emissivities of micron-sized particles of C, MgO, Al_2O_3, and ZrO_2. Final report, 3:26636 (AD-A-042144)
ALUMINIUM OXIDES/MECHANICAL PROPERTIES
Ceramic technology readiness program. Third monthly technical progress report, November 28, 1977-January 1, 1978, 3:26144 (FE/2664-3)
ALUMINIUM OXIDES/PHOTOLUMINESCENCE
Characteristics of the excitation of Al_2O_3-Eu and Y_2O_3-Eu surface luminescence centers, 3:26640
ALUMINIUM OXIDES/PHYSICAL PROPERTIES
Ceramic technology readiness program. Third monthly technical progress report, November 28, 1977-January 1, 1978, 3:26144 (FE/2664-3)
ALUMINIUM SILICATES/CHEMICAL REACTION KINETICS
Internally consistent thermodynamic data (abstract), 3:26118
AMALGAMS
See MERCURY ALLOYS
AMCHITKA ISLAND AREA/ALGAE
Ecology of marine algae (Prasiola, Rhodochorton, Porphyra, Ulothrix, Alaria, Fucus), 3:26925 (TID-26712)
AMCHITKA ISLAND AREA/AQUATIC ECOSYSTEMS
Aquatic ecology, 3:26924 (TID-26712)

Limnology, 3:26923 (TID-26712)
AMCHITKA ISLAND AREA/BIRDS
Avifaunal investigations, 3:26903 (TID-26712)
AMCHITKA ISLAND AREA/ECOLOGY
Environment of Amchitka Island, Alaska, 3:26895 (TID-26712)
AMCHITKA ISLAND AREA/FISHES
Marine fish communities, 3:26927 (TID-26712)
AMCHITKA ISLAND AREA/GEOGRAPHY
Geographic setting, 3:27004 (TID-26712)
AMCHITKA ISLAND AREA/GEOLOGY
Geologic history, 3:27005 (TID-26712)
Geomorphology, 3:26900 (TID-26712)
AMCHITKA ISLAND AREA/GEOMORPHOLOGY
Geomorphology, 3:26900 (TID-26712)
AMCHITKA ISLAND AREA/GROUND WATER
Hydrology, 3:26896 (TID-26712)
AMCHITKA ISLAND AREA/HUMAN POPULATIONS
History, 1741-1967, 3:26922 (TID-26712)
AMCHITKA ISLAND AREA/HYDROLOGY
Hydrology, 3:26896 (TID-26712)
AMCHITKA ISLAND AREA/INVERTEBRATES
Marine invertebrates in rocky intertidal communities, 3:26926 (TID-26712)
AMCHITKA ISLAND AREA/LIMNOLOGY
Limnology, 3:26923 (TID-26712)
AMCHITKA ISLAND AREA/MAMMALS
Ecological interactions involving the sea otter, 3:26928 (TID-26712)
Population estimates and feeding behavior of sea otters, 3:26942 (TID-26712)
Sea mammals: resources and population, 3:26938 (TID-26712)
Sea otter metabolism and heat economy, 3:26970 (TID-26712)
AMCHITKA ISLAND AREA/OCEANOGRAPHY
Oceanography, 3:27021 (TID-26712)
AMCHITKA ISLAND AREA/POLLUTION
Ecological consequences of nuclear testing, 3:26907 (TID-26712)
Polychlorinated biphenyls in the ecosystems, 3:26906 (TID-26712)
AMCHITKA ISLAND AREA/RATS
Status of the Norway rat, 3:26904 (TID-26712)
AMCHITKA ISLAND AREA/RESOURCE CONSERVATION
Sea mammals: resources and population, 3:26938 (TID-26712)
AMCHITKA ISLAND AREA/SOILS
Soils, 3:26901 (TID-26712)
AMCHITKA ISLAND AREA/TEMPERATURE MONITORING
Weather and climate, 3:26897 (TID-26712)
AMCHITKA ISLAND AREA/TERRESTRIAL ECOSYSTEMS
Terrestrial plant ecology, 3:26902 (TID-26712)
AMCHITKA ISLAND AREA/TOPOGRAPHY
Soils, 3:26901 (TID-26712)
AMCHITKA ISLAND AREA/TOPOLOGICAL MAPPING
Geographic setting, 3:27004 (TID-26712)
AMCHITKA ISLAND AREA/WEATHER
Weather and climate, 3:26897 (TID-26712)
AMCHITKA ISLAND AREA/WILD ANIMALS
History, 1741-1967, 3:26922 (TID-26712)
AMERICIUM 241/BIOLOGICAL RADIATION EFFECTS
^{239}Pu and ^{241}Am contamination of small vertebrates in NAEG study areas of NTS and TTR, 3:26915 (NVO-171)
AMERICIUM 241/ENVIRONMENTAL TRANSPORT
Plutonium distribution in a desert pavement-desert mound soil system in area 11, 3:26910 (NVO-171)
Plutonium distribution in the environs of the Nevada Test Site: status report, 3:26911 (NVO-171)
Radionuclide transport (Hanford terrestrial ecosystems), 3:25948 (PNL-2253)
AMIDES
See also ASPARAGINE
AMIDES/CHEMICAL PREPARATION
Direct synthesis of anilides from nitroarenes, 3:26687
AMINO ACIDS
See also ASPARAGINE
LYSINE
TRYPTOPHAN
AMINO ACIDS/BIOCHEMICAL REACTION KINETICS
Yeast mitochondrial DNA specifies tRNA for 19 amino acids. Deletion mapping of the tRNA genes, 3:26950
AMINO ACIDS/CHEMICAL RADIATION EFFECTS
Development of methods for determining organic free radical structures by electron spin resonance and application to the radiation chemistry of nucleic acid model compounds (X radiation), 3:26694 (UR/3490/LCP-6)
AMINO ACIDS/YIELDS
Anaerobic fermentation of animal and crop residues: summary. Quarterly progress report (second), April 1, 1977-June 10, 1977, 3:26017 (COO/2991-19)
AMINOSUCCINAMIC ACID-ALPHA
See ASPARAGINE
AMMONIA/CATALYTIC EFFECTS
Homogeneous catalytic hydrocracking processes for conversion of coal to liquid fuels: basic and exploratory research. Quarterly report No. 7, May 1, 1977-July 31, 1977, 3:25653 (FE-2202-21)
AMMONIA/CHEMISORPTION
Absorption of ammonia with organic solvents, 3:25969
Evidence for the structures of adsorbed NH_3 and H_2O on RU(001), 3:25968 (AD-A-043330)
AMMONIA/EQUILIBRIUM
Preparation of a coal conversion systems technical data book. Project 8979 quarterly report, May 1-July 31, 1977 (NH_3-CO_2-H_2S-H_2O, cyclohexane-H_2O), 3:25633 (FE-2286-20)
AMMONIA/PRODUCTION
Calculation and optimization of existing energy-technological systems for ammonia production, 3:25972
AMMONIA/SYNTHESIS
Conditions for regenerating an iron-molybdenum-tungsten catalyst used in ammonia synthesis, 3:25970
Economic efficiency of optimizing existing units for carbon monoxide conversion, 3:25971
ANAEROBIC DIGESTION/BIOCHEMISTRY
Biochemistry of methanogeness, 3:26026 (SRO-0888-2)
ANAEROBIC DIGESTION/CHEMICAL REACTION KINETICS
Promoting faster anaerobic digestion: summary of progress and plans, 3:26008 (COO/2991-19)
ANAEROBIC DIGESTION/ECONOMICS
Energy relationships for a 320-acre Iowa farm: an attempt to increase production of grain and meat while rendering the farm energy self-sufficient by generating methane through anaerobic fermentation of residues, 3:26020 (ERDA/USDA-19464/76/FR-3)
ANAEROBIC DIGESTION/RESEARCH PROGRAMS
Anaerobic digestion technology. Quarterly progress meeting, Ithaca, New York, June 20-22, 1977, 3:26005 (COO/2991-19)
ANEMIAS/GENETICS
Inborn anemias in mice. Progress report, 1 May 1976-31 July 1977, 3:26987 (COO-3264-16)
ANIMAL CELLS
See also GERM CELLS
SOMATIC CELLS
TUMOR CELLS
ANIMAL CELLS/BIOLOGICAL RADIATION EFFECTS
Biological effects of ionizing radiation at the molecular, cellular, and organismal levels. Triannual progress report, July 15, 1974-October 14, 1977, 3:26984 (TID-28055)
Radiation effects on cells and chromosomes (A bibliography with abstracts). Report for 1964-August 1977, 3:26988 (NTIS/PS-77/0753)
ANIMAL CELLS/CYTOLOGY
Clustering algorithm for mixtures of monotone densities, 3:26962 (LA-7120-MS)
ANIMAL CELLS/ELECTRON MICROSCOPY
Decidual cell secretion, a unique mode of exocytosis, 3:26955 (CONF-770504-)
Enzyme localizations in hepatocytes following triton WR-1339 injection, 3:26954 (CONF-770504-)
Proceedings of the 14th annual electron microscopy colloquium, 3:26952 (CONF-770504-)
ANIMAL CELLS/KARYOTYPE
Mathematical model of the connection between the DNA karyogram and the cell cycle. Part 1. Derivation of the DNA frequency distribution from the duration of the individual phases of the cell cycle, 3:26964 (LA-tr-78-3)
ANIMAL CELLS/LYSOSOMES
Enzyme localizations in hepatocytes following triton WR-1339 injection, 3:26954 (CONF-770504-)
ANIMAL CELLS/SAMPLING
Clustering algorithm for mixtures of monotone densities, 3:26962 (LA-7120-MS)
ANIMALS
(See also specific animal names.)
See also INVERTEBRATES
WILD ANIMALS
ANIMALS/CONTAMINATION
Radionuclides in air, water, and biota (^{40}K, ^{7}Be, ^{137}Cs), 3:26934 (TID-26712)
ANNULAR CORE PULSE REACTOR
See ACPR REACTOR
ANTENNAS/MATHEMATICAL MODELS
Bivariate interpolation approach for efficiently and accurately modelling antennas near a halfspace, 3:26776
ANTHRACENE/CRYSTAL STRUCTURE
Pressure dependence of the lattice parameters of anthracene up to 5.4 kbar and a re-evaluation of the elastic constants, 3:26643
ANTHRACENE/ELASTICITY
Pressure dependence of the lattice parameters of anthracene up to 5.4 kbar and a re-evaluation of the elastic constants, 3:26643

ANTHRACITE/CHEMICAL ANALYSIS
Prospects for carbon-13 nuclear magnetic resonance analysis of solid fossil-fuel materials, 3:25668
ANTIBIOTICS/BIOCHEMICAL REACTION KINETICS
Yeast mitochondrial DNA specifies tRNA for 19 amino acids. Deletion mapping of the tRNA genes, 3:26950
ANTILAMBDA PARTICLES/PARTICLE PRODUCTION
Inclusive baryon production in e^+e^- annihilation, 3:27103
Inclusive production of neutral strange particles in 250-GeV/c π^-p interactions (Cross sections), 3:27145
ANTIMONY/ION EXCHANGE
Cation exchange of 53 elements in nitric acid, 3:26665 (LA-7083)
ANTIMONY/QUANTITATIVE CHEMICAL ANALYSIS
Fate of trace and minor constituents of coal during gasification. Final task report, 3:25641 (PB-270913)
ANTIMONY COMPOUNDS/KNIGHT SHIFT
Systematics in the Knight shift of rare-earth monopnictides, 3:26600
ANTIMONY IONS/ENERGY LOSSES
A boltzmann transport code for ion penetration in matter. Memorandum report, 3:27399 (AD-A-043502)
ANTIMUONS
See MUONS PLUS
ANTINEUTRINO-ELECTRON INTERACTIONS/ELASTIC SCATTERING
Gauge theories: an introduction (Review lectures, V-A theory, intermediate vector boson model), 3:27295
ANTINEUTRINO-NUCLEON INTERACTIONS/PAIR PRODUCTION
Dimuon distribution from production of heavy particles in high-energy ν and nu-bar reactions, 3:27187
ANTINEUTRINO-NUCLEON INTERACTIONS/SCALE INVARIANCE
Distinguishing scaling violations from new currents, 3:27194
ANTIPROTON BEAMS/BEAM LUMINOSITY
Comparison of anti p anti p and pp luminosities at Fermilab, 3:27215 (ANL-HEP-CP-77-81)
ANTIPROTONIC ATOMS
See HADRONIC ATOMS
ANTIPROTONS/ABSORPTION
Light antiprotonic atoms and quasinuclear mesons, 3:27236
ANTIPROTONS/PARTICLE PRODUCTION
Inclusive baryon production in e^+e^- annihilation, 3:27103
ANTIREFLECTION COATINGS/OPTIMIZATION
Optimization of coatings for flat plate solar collectors, Phase II. Final report, 28 June 1976-27 June 1977, 3:26060 (COO-2930-12)
ANTS
See INSECTS
APPALACHIA/ENERGY FACILITIES
Technology facility siting characteristics and infrastructure needs. Final report, 3:26940 (PB-270899)
APPLIANCES
See also AIR CONDITIONERS
REFRIGERATORS
APPLIANCES/DEMAND FACTORS
Methodology for predicting the demand for new electricity-using goods. Final report, 3:26498 (EPRI-EA-593)
AQUATIC ECOSYSTEMS/POLLUTION
Ecological consequences of nuclear testing, 3:26907 (TID-26712)
AQUATIC ECOSYSTEMS/PRODUCTIVITY
Aquatic ecology, 3:26924 (TID-26712)
ARC WELDING/THERMAL ANALYSIS
HEATING5 analysis of a welding problem, 3:26594 (K/CSD/INF-77/17)
ARCHAEOLOGY
Prehistoric human occupation of the Rat Islands, 3:26898 (TID-26712)
ARGON/EMISSION SPECTRA
Spectral-line-blending calculations applied to highly excited atomic levels in high-density argon plasmas, 3:27516
ARGON/ION-ATOM COLLISIONS
Z^3 effect in the ionization cross section of argon by 1.2- and 2.0-MeV α particles, 3:27401
ARGON/STOPPING POWER
Z^3 effect in the ionization cross section of argon by 1.2- and 2.0-MeV α particles, 3:27401
ARGON 38/HIGH SPIN STATES
High-spin states in $A \cong 40$ nuclei: Data for ^{38}Ar and ^{38}K, 3:27346
ARGON 39/ENERGY LEVELS
Low-lying states in ^{39}Ar from the ^{37}Cl(α,d)^{39}Ar reaction, 3:27345
ARGON IONS/ORIENTATION
Production of orientation and alignment in heavy-ion-surface collisions, 3:27078
ARIZONA/ENERGY SOURCE DEVELOPMENT
Western States energy resource development update 1976, 3:26503
AROMATICS
See also BENZENE
TETRALIN
AROMATICS/**CHEMICAL PREPARATION**
Direct synthesis of anilides from nitroarenes, 3:26687
AROMATICS/**CHEMILUMINESCENCE**
Chemical production of excited states: adventitious biological chemiluminescence of carcinogenic polycyclic aromatic hydrocarbons, 3:26946 (COO-3277-44)
AROMATICS/**THERMODYNAMIC PROPERTIES**
Chemical thermodynamic properties of ethylbenzene, 3:27414
ARSENIC/ION EXCHANGE
Cation exchange of 53 elements in nitric acid, 3:26665 (LA-7083)
ARSENIC 67/BETA-PLUS DECAY
New isotopes of interest to explosive nucleosynthesis (Half-lives, branching ratios, J, π), 3:27355 (ANL-77-60)
ARSENIC ALLOYS
See ARSENIDES
ARSENIDES/KNIGHT SHIFT
Systematics in the Knight shift of rare-earth monopnictides, 3:26600
ARSONIC ACIDS/QUANTITATIVE CHEMICAL ANALYSIS
Fate of trace and minor constituents of coal during gasification. Final task report, 3:25641 (PB-270913)
ASHES
See also FLY ASH
ASHES/**CHEMICAL ANALYSIS**
Composition and variation of pulverized fuel ash obtained from the combustion of sub-bituminous coals, New Zealand, 3:25673
ASHES/**CHEMICAL COMPOSITION**
Composition and variation of pulverized fuel ash obtained from the combustion of sub-bituminous coals, New Zealand, 3:25673
ASHES/**DISSOLUTION**
Design and operation of air-lift, circulated, cascade dissolver systems, 3:26667 (RFP-2716)
ASHES/**MELTING**
Study of the slagging properties of Kuznetsk coal ash, 3:25675
ASPARAGINE/CHEMICAL RADIATION EFFECTS
Development of methods for determining organic free radical structures by electron spin resonance and application to the radiation chemistry of nucleic acid model compounds (X radiation), 3:26694 (UR/3490/LCP-6)
ASPARAMIDE
See ASPARAGINE
ASPHALTENES/CHEMICAL COMPOSITION
Investigations on Romashkino asphaltic bitumen. III. Fractionation of asphaltenes using ion-exchange chromatography, 3:25781
ASPHALTENES/**CHEMICAL REACTIONS**
Ozonolysis of asphaltenes, 3:25821
ASPHALTENES/**ION EXCHANGE CHROMATOGRAPHY**
Investigations on Romashkino asphaltic bitumen. III. Fractionation of asphaltenes using ion-exchange chromatography, 3:25781
ASPHALTENES/**MOLECULAR STRUCTURE**
Ozonolysis of asphaltenes, 3:25821
ASPHALTS
See also ASPHALTENES
ASPHALTS/**PRODUCTION**
Influence of air input rate on oxidation of residuum in the presence of ferric chloride, 3:25789
ASTROCYTOMAS
See NEOPLASMS
ASTRON/ELECTRON BEAMS
Experimental studies on generation and behaviour of field-reversing E- and P-layers, 3:27494
ASTROPHYSICS/PHOTON-PHOTON INTERACTIONS
Implications of a nonzero neutrino mass for the process $\gamma\gamma \rightarrow \nu$nu-bar, 3:27200
ATC DEVICES/ELECTRON TEMPERATURE
Spectroscopic measurements of ion temperature in ATC tokamak with RF and neutral-beam heating, 3:27478
ATC DEVICES/**IMPURITIES**
Calculations of impurity radiation and its effects on tokamak experiments, 3:27627
ATHABASCA DEPOSIT/HYDRAULIC FRACTURING
Stress state and hydraulic fracturing in the Athabasca Oil Sands, 3:25892
ATHABASCA DEPOSIT/**IN-SITU COMBUSTION**
In situ recovery process for the oil sands of Alberta, 3:25898
Low temperature oxidation process for the recovery of bitumen, 3:25896
ATHABASCA DEPOSIT/**IN-SITU PROCESSING**
In situ recovery process for the oil sands of Alberta, 3:25898
Oil sands in situ projects continue at impressive rate, 3:25897
ATHABASCA DEPOSIT/**STEAM INJECTION**
Low temperature oxidation process for the recovery of bitumen, 3:25896
ATHABASCA DEPOSIT/**STRESS ANALYSIS**
Stress state and hydraulic fracturing in the Athabasca Oil Sands, 3:25892

ATMOSPHERIC EXPLOSIONS/NEUTRON TRANSPORT
Energy deposition rates and Compton electron currents from low-altitude bursts as a function of source energy. Interim report 17 Nov 76-1 Nov 77, 3:27042 (AD-A-046092)
ATMOSPHERIC EXPLOSIONS/PHOTON TRANSPORT
Energy deposition rates and Compton electron currents from low-altitude bursts as a function of source energy. Interim report 17 Nov 76-1 Nov 77, 3:27042 (AD-A-046092)
ATMOSPHERIC EXPLOSIONS/SIMULATION
Characteristics of late-time striations observed during operation stress, 3:27044 (LA-UR-77-2835)
ATMOSPHERIC PRECIPITATIONS/WASHOUT
Rainout, 3:26886 (AD-A-046201)
ATOM-ATOM COLLISIONS/CHARGE EXCHANGE
Collisions of H^- ions and fast H^0 atoms in a Cs vapor target, 3:27068
ATOMIC BOMBS
See NUCLEAR WEAPONS
ATOMIC EXPLOSIONS
See NUCLEAR EXPLOSIONS
ATOMIC IONS/ELECTRON-ION COLLISIONS
Distorted-wave theory of electron-ion collisions. I. Direct excitation and ionization, 3:27079
ATOMIC MODELS/ENERGY-LEVEL TRANSITIONS
Coherent dynamics of N-level atoms and molecules. II. Analytic solutions, 3:27086
ATOMIC MODELS/NUMERICAL SOLUTION
Coherent dynamics of N-level atoms and molecules. I. Numerical experiments, 3:27085
ATOMIC WEAPONS
See NUCLEAR WEAPONS
ATOMS
See also HADRONIC ATOMS
ISOELECTRONIC ATOMS
ATOMS/ENERGY-LEVEL TRANSITIONS
Multiphoton absorption in the presence of two finite-bandwidth lasers, 3:27051
ATOMS/EXCITED STATES
Ordering of the excited-state energy levels of various atoms and their isoelectronic ions. II, 3:27053
ATOMS/PHOTOIONIZATION
Selective single atom detection in a 10^{19} atom background, 3:27062
ATOMS/RESEARCH PROGRAMS
Physics Division annual review, 1 April 1976-31 March 1977 (ANL), 3:27312 (ANL-77-60)
ATOMS/SLOWING-DOWN
Coherent excitation of nuclei and atoms on passing through a crystal. Effect of slowing down, 3:27402
AUGER ELECTRON SPECTROSCOPY/SENSITIVITY
Theory of valence-band Auger spectra: GaAs(110), 3:26651
AURORAE/EMISSION SPECTRA
Data processing and analysis for icecap and related projects. Final scientific report, 4 December 1972-3 December 1976, 3:27034 (AD-A-042261)
Ionospheric irregularities: optical support of HAES scintillation experiments. Final report, 15 December 1975-31 January 1977, 3:27038 (AD-A-043666)
AURORAE/INFORMATION SYSTEMS
Data processing and analysis for icecap and related projects. Final scientific report, 4 December 1972-3 December 1976, 3:27034 (AD-A-042261)
AURORAE/INFRARED SPECTRA
EXCEDE II. Environmental research papers, 3:27035 (AD-A-042491)
AUSTRIA/URANIUM DEPOSITS
Uranium geochemical prospecting in Salzburg Province, Austria, 3:25922
AUTOMOBILES/ENERGY STORAGE SYSTEMS
Energy and Resource Planning Group FY 1977 annual report (Use of LLL Energy Model (LLLEM)), 3:26495 (UCRL-50029-77)
AUTOMOBILES/FLYWHEELS
Increased fuel economy in transportation systems by use of energy management: third year's program. Final report, 1 May-1 July 1976, 3:26583 (PB-269607)
AUTOMOBILES/MARKET
Methodology for predicting the demand for new electricity-using goods. Final report, 3:26498 (EPRI-EA-593)
AUTOMOBILES/MECHANICAL TRANSMISSIONS
Automobile drivelines. Final report, June-December 1974, 3:26586 (PB-269591)
Traction drives: a review of their configurations and considerations for their selection for automotive applications. Technical report, 3:26585 (MTI-78TR11)
AUTOMOBILES/PROPULSION
Energy and Resource Planning Group FY 1977 annual report (Use of LLL Energy Model (LLLEM)), 3:26495 (UCRL-50029-77)
AUTOMOBILES/STIRLING ENGINES
Materials technology assessment for Stirling engines, 3:26578 (CONS/1011-22)
AUTOMOBILES/STRATIFIED CHARGE ENGINES
Theoretical model for two-phase fuel injection in stratified charge engines, 3:26588 (UCRL-79534)
AUTOMOBILES/THERMAL INSULATION
Resonaflex, the anticorrosive multi-purpose plate for thermal and acoustic insulation, 3:26584
AZORES ISLANDS/LAVA
Rare earth and other trace elements in historic Azorean lavas, 3:27009

B

BABESIDAE/ULTRASTRUCTURAL CHANGES
Ultrastructure of Babesia equi and the parasitized equine erythrocyte, 3:26981 (CONF-770504-)
BACTERIA
See also ESCHERICHIA COLI
RHODOPSEUDOMONAS
BACTERIA/BIOLOGICAL INDICATORS
Literature survey of bacterial, fungal, and Drosophila assay systems used in the evaluation of selected chemical compounds for mutagenic activity, 3:26994 (ORNL/EMIC-9)
BACTERIA/BIOLOGICAL RADIATION EFFECTS
Thermoradiation treats sewage sludge, 3:26576
BACTERIOPHAGES/BIOLOGICAL INDICATORS
Literature survey of bacterial, fungal, and Drosophila assay systems used in the evaluation of selected chemical compounds for mutagenic activity, 3:26994 (ORNL/EMIC-9)
BACTERIOPHAGES/TEMPERATURE EFFECTS
Effects of high temperature on infections of E. coli B by bacteriophage T4D and its mutant in gene regA, 3:26976 (UR-3490/LCP-2)
BAG MODEL/ENERGY LEVELS
Baryon excitations in the bag model, 3:27216 (SLAC-PUB-1774)
BAG MODEL/GAUGE INVARIANCE
Comments on a paper by Callan, Coote, and Gross (Quark binding), 3:27265
BAG MODEL/GLUON MODEL
Mesons from gluons, 3:27219
BAG MODEL/LECTURES
Quark confinement (Lectures), 3:27206 (SLAC-PUB-2020)
BAG MODEL/MEETINGS
Quark confinement and field theory, 3:27160
BAND THEORY/CORRELATIONS
Lithium local-orbital energy bands using Kohn-Sham and near-Hartree-Fock exchange, 3:26606
BARIUM/ENERGY-LEVEL TRANSITIONS
Atomic diamagnetism and diamagnetically induced configuration mixing in laser-excited barium, 3:27048
BARIUM/ZEEMAN EFFECT
Atomic diamagnetism and diamagnetically induced configuration mixing in laser-excited barium, 3:27048
BARYONS/BAG MODEL
Baryon excitations in the bag model, 3:27216 (SLAC-PUB-1774)
BARYONS/DECAY
Weak radiative decays of baryons in SU(4), 3:27191
BARYONS/ENERGY LEVELS
Baryon excitations in the bag model, 3:27216 (SLAC-PUB-1774)
BARYONS/PARTICLE MULTIPLETS
Does the baryon spectrum reveal a diquark structure, 3:27225
BARYONS/QUARK MODEL
Does the baryon spectrum reveal a diquark structure, 3:27225
BASALT/CHEMICAL COMPOSITION
Rare earth and other trace elements in historic Azorean lavas, 3:27009
BASEBALL DEVICES/LASER-PRODUCED PLASMA
Target-plasma production by laser irradiation of a pellet in the Baseball II-T experiment, 3:27531 (UCRL-52363)
BATTERIES (ELECTRIC)
See ELECTRIC BATTERIES
BATTERY SEPARATORS/ELECTRIC CONDUCTIVITY
Measurement of battery separator resistances in low impedance conductivity cells by ac bridge techniques. Progress report (Possible errors due to electrode impedance), 3:26488 (AD-A-042182)
BEAM DYNAMICS
(Particle beam motion inside an accelerator.)
Quantum lifetime in electron storage rings, 3:26811 (SLAC-PUB-1884)
BEAM-PLASMA SYSTEMS/BEAM TRANSPORT
Accelerated thermalization of an inhomogeneous beam-plasma system, 3:27514

Transportation of relativistic electron beam in a plasma, 3:27486
BEAM-PLASMA SYSTEMS/PLASMA INSTABILITY
Observation of electron-ion instability in counterstreaming ion beams and plasma system, 3:27573
BEAM-PLASMA SYSTEMS/PLASMA WAVES
Computer study of many waves in the small cold beam and plasma interaction, 3:27578
Observation of electron-ion instability in counterstreaming ion beams and plasma system, 3:27573
BEAM-PLASMA SYSTEMS/SOLITONS
Effects of an ion beam on the motion of solitons in an ion beam-plasma system, 3:27576
BEARINGS/DESIGN
Self-alignment in thrust bearings, 3:25760
BEES
See INSECTS
BELLOWS/STRESS ANALYSIS
Stress analysis of the bellows and its connection with a thick ring of the vacuum vessel, 3:27702 (JAERI-M-6822)
BELT PINCH/MAGNETOHYDRODYNAMICS
Free-boundary equilibrium computations for strongly elongated Belt Pinch plasmas, 3:27519
BENZALDEHYDE/OXIDATION
Distinctive catalysis by phosphonium and sulfonium compounds in low-temperature liquid-phase hydrocarbon oxidation, 3:26688
BENZENE/MOLECULE-MOLECULE COLLISIONS
Energy transfer cross sections in relation to generalized oscillator strengths for the donor-acceptor pair benzene-acetone, 3:27065
BENZENE/THERMODYNAMIC PROPERTIES
Preparation of a coal conversion systems technical data book. Project 8979 monthly status report, November 1-November 30, 1977, 3:25615 (FE-2286-25)
BENZOPYRENE/BIOCHEMICAL REACTION KINETICS
Comparative metabolism of benzo(a)pyrene in rodent liver and embryonic cells in tissue culture, 3:26995 (CONF-771147-2)
BENZOPYRENE/METABOLISM
Comparative metabolism of benzo(a)pyrene in rodent liver and embryonic cells in tissue culture, 3:26995 (CONF-771147-2)
BER-2 REACTOR/FIRES
Concerning the press report on 'Short circuit in the nuclear reactor' at the Hahn-Meitner Institute in Berlin, 3:26470
BERLIN-2 RESEARCH REACTOR
See BER-2 REACTOR
BERYLLIUM/EMISSION SPECTROSCOPY
Determination of trace elements in soft, hard, and saline waters by the inductively coupled plasma, multi-element atomic emission spectroscopic (ICP-MAES) technique, 3:26664
BERYLLIUM 7/ENVIRONMENTAL EFFECTS
Radionuclides in air, water, and biota (^{40}K, ^{7}Be, ^{137}Cs), 3:26934 (TID-26712)
BERYLLIUM 7/NUCLEAR REACTION YIELD
Mechanisms for Li and Be production in the $^{14}N + {}^{12}C$ reaction, 3:27336
BERYLLIUM 9/NUCLEAR REACTION YIELD
Mechanisms for Li and Be production in the $^{14}N + {}^{12}C$ reaction, 3:27336
BERYLLIUM 9 REACTIONS/ELASTIC SCATTERING
Low energy elastic scattering from ^{28}Si targets using projectiles with $9 < \text{or} = A < \text{or} = 18$, 3:27344
BERYLLIUM 9 TARGET/NEUTRON REACTIONS
Coherent dissociation of neutrons on nuclei at 100-300 GeV/c, 3:27123
Inclusive charged-particle production in neutron-nucleus collisions, 3:27121
BERYLLIUM 9 TARGET/PHOTONUCLEAR REACTIONS
psi and excess leptons in photoproduction, 3:27099 (SLAC-PUB-1728)
BERYLLIUM 9 TARGET/PION PLUS REACTIONS
Properties of inclusive (π^+,π^0) reactions in nuclei, 3:27334
BERYLLIUM 9 TARGET/PROTON REACTIONS
Empirical formula for inclusive proton spectra between 10 and 300 GeV, 3:27232
Inclusive production of Λ^0 hyperons by 300-GeV protons: A dependence, 3:27129
BERYLLIUM MODERATORS
See BERYLLIUM
BETA DOSIMETRY/THERMOLUMINESCENT DOSEMETERS
Photon and beta response of a new thermoluminescent dosimeter badge, 3:26824 (LA-UR-77-3001)
BI-GAS PROCESS/CATALYSTS
Gas generator research and development BI-GAS Process. 76th monthly progress report, December 1977, 3:25627 (FE-1207-40)
BI-GAS PROCESS/COMPARATIVE EVALUATIONS
Quarterly technical progress report, October-December 1977, 3:25631 (FE-2240-79)
BIOLOGICAL SHIELDS
Nuclear reactor (Patent), 3:26478
BIOMASS
(All growing organic matter such as plants, trees, grasses, and algae.)
See also PLANTS
BIOMASS/ANAEROBIC DIGESTION
Anaerobic fermentation of agricultural residues: potential for improvement and implementation. Fourth quarter progress report, March 2, 1977-June 15, 1977, 3:26010 (COO/2991-19)
BIOMASS/ENERGY SOURCE DEVELOPMENT
Energy from biomass: an overview of environmental aspects, 3:26004 (CONF-780109-3)
BIOMASS/INVENTORIES
Solar biomass energy: an overview of U.S. potential, 3:26027
BIOMASS/PRODUCTION
Multidisciplinary research program directed toward utilization of solar energy through bioconversion of renewable resources. Progress report, 3:26023 (SRO-0888-2)
BIRDS/COMMUNITIES
Biotic components, 3:25946 (PNL-2253)
BIRDS/HABITAT
Habitat requirements and population characteristics of the clapper rail (Rallus longirostris yumanesis) in the Imperial Valley of California, 3:26943 (UCRL-13813)
BIRDS/POPULATION DYNAMICS
Avifaunal investigations, 3:26903 (TID-26712)
Habitat requirements and population characteristics of the clapper rail (Rallus longirostris yumanesis) in the Imperial Valley of California, 3:26943 (UCRL-13813)
BIRDS/TAXONOMY
Avifaunal investigations, 3:26903 (TID-26712)
BISMUTH/ION EXCHANGE
Cation exchange of 53 elements in nitric acid, 3:26665 (LA-7083)
BISMUTH/QUANTITATIVE CHEMICAL ANALYSIS
Fate of trace and minor constituents of coal during gasification. Final task report, 3:25641 (PB-270913)
BISMUTH/SOUND WAVES
Speed of ultrasound and thermophysical properties of the liquid metals of Sn, Cd, Bi and their binary alloys Cd-Bi and Sn-Bi, 3:26620
BISMUTH 209 TARGET/NEUTRON REACTIONS
Cross sections for (n,2n) and (n,3n) reactions above 14 MeV, 3:27353
BISMUTH 209 TARGET/**PHOTONUCLEAR REACTIONS**
Pre-equilibrium particle decay in the photonuclear reactions, 3:27327
BISMUTH ALLOYS/SOUND WAVES
Speed of ultrasound and thermophysical properties of the liquid metals of Sn, Cd, Bi and their binary alloys Cd-Bi and Sn-Bi, 3:26620
BISMUTH COMPOUNDS/KNIGHT SHIFT
Systematics in the Knight shift of rare-earth monopnictides, 3:26600
BITTER SPAR
See DOLOMITE
BITUMENS
See also ASPHALTS
COAL TAR
BITUMENS/CHEMICAL COMPOSITION
Chemical composition of athabasca bitumen, 3:25900
BITUMENS/RECOVERY
Heavy oil sand in-situ pilot plants in Alberta (past and present), 3:25895
Low temperature oxidation process for the recovery of bitumen, 3:25896
BITUMENS/REFINING
Role for nuclear energy in the recovery of oil from the tar sands of Alberta, 3:25894
BITUMENS/STRUCTURAL CHEMICAL ANALYSIS
Hydrovisbreaking of Athabasca bitumen and its reaction mechanism, 3:25899
BITUMENS/THERMAL CRACKING
Hydrovisbreaking of Athabasca bitumen and its reaction mechanism, 3:25899
BITUMENS/VISCOSITY
Hydrovisbreaking of Athabasca bitumen and its reaction mechanism, 3:25899
BITUMINOUS COAL/CHEMICAL ANALYSIS
Fate of trace and minor constituents of coal during gasification. Final task report, 3:25641 (PB-270913)
BITUMINOUS COAL/**HYDROGENATION**
Basic studies of coal pyrolysis and hydrogasification. Quarterly progress report, July 1, 1977-September 30, 1977, 3:25619 (FE-MIT-2295T26-3)
BITUMINOUS COAL/**PYROLYSIS**
Basic studies of coal pyrolysis and hydrogasification. Quarterly progress report, July 1, 1977-September 30, 1977, 3:25619 (FE-MIT-2295T26-3)
BLACK COATINGS
Selective black for absorption of solar energy (Patent), 3:26067
BLACK COATINGS/EMISSIVITY
Black chrome on commercially electroplated tin as a solar selective coating, 3:26061 (ERDA/NASA/1060-77/1)

BLACK COATINGS/FABRICATION
Improved black nickel coatings for flat plate solar collectors, 3:26072
New chrome black selective absorbing surface, 3:26064
BLACK COATINGS/OPTICAL PROPERTIES
Improved black nickel coatings for flat plate solar collectors, 3:26072
New chrome black selective absorbing surface, 3:26064
BLACK COATINGS/OPTIMIZATION
Optimization of coatings for flat plate solar collectors, Phase II. Final report, 28 June 1976-27 June 1977, 3:26060 (COO-2930-12)
BLACK COATINGS/REFLECTIVITY
Black chrome on commercially electroplated tin as a solar selective coating, 3:26061 (ERDA/NASA/1060-77/1)
Ellipsometry in the study of selective radiation: absorbing surfaces, 3:26063
BLANKETS (BREEDING)
See BREEDING BLANKETS
BLOOD FLOW/RESPONSE MODIFYING FACTORS
Bone-seeking radionuclides: an in vivo study of factors affecting skeletal uptake, 3:26972
BLOOD FORMATION/GENETICS
Inborn anemias in mice. Progress report, 1 May 1976-31 July 1977, 3:26987 (COO-3264-16)
BLOWDOWN/FLUID FLOW
Computer code for nuclear reactor core thermal transients (PWR), 3:26446
BLOWDOWN/HEAT TRANSFER
Computer code for nuclear reactor core thermal transients (PWR), 3:26446
BLOWDOWN/MATHEMATICAL MODELS
Computer code for nuclear reactor core thermal transients (PWR), 3:26446
Method for the analysis of blowdown induced forces in a reactor vessel, 3:26433 (CENPD-252-NP)
BLOWDOWN/PRESSURE SUPPRESSION
Instrumenting a pressure suppression experiment for a MK I boiling water reactor: another measurements engineering challenge, 3:26444 (UCRL-52314)
BLOWDOWN/SIMULATION
PWR Blowdown Heat Transfer Separate-Effects Program. Thermal-Hydraulic Test Facility experimental data report for test 105, 3:26440 (ORNL/NUREG/TM-143)
BLOWDOWN/TEST FACILITIES
PWR Blowdown Heat Transfer Separate-Effects Program. Thermal-Hydraulic Test Facility experimental data report for test 105, 3:26440 (ORNL/NUREG/TM-143)
BOILER FUEL/FUEL SUBSTITUTION
Coal gasification study handbook. Final report, 3:25620 (AD-A-042385)
BOILER FUEL/HEATING
Design development and experience of operation of a high-temperature residual oil preheater, 3:26185
BOILERS/BIBLIOGRAPHIES
Boiler corrosion. Volume 2. 1975-August, 1977 (citations from the Engineering Index Data Base). Report for 1975-August 1977, 3:26191 (NTIS/PS-77/0796)
BOILERS/BURNERS
Brookhaven National Laboratory Burner-Boiler/Furnace Efficiency Test Project. Hydronic equipment findings report reference manual, 3:26777 (BNL-50644)
BOILERS/CORROSION
Boiler corrosion (citations from the NTIS data base). Report for 1964-August 1977, 3:26153 (NTIS/PS-77/0795)
Boiler corrosion. Volume 2. 1975-August, 1977 (citations from the Engineering Index Data Base). Report for 1975-August 1977, 3:26191 (NTIS/PS-77/0796)
Thermodynamic phase stability diagrams for the analysis of corrosion reactions in coal gasification/combustion atmospheres. Interim report, 3:25626 (EPRI-FP-539)
BOILERS/CORROSION PROTECTION
Prevention of fouling in waste-fired vessels (In German), 3:26151 (AED-Conf-77-195-006)
BOILERS/DEPOSITS
Study of the slagging properties of Kuznetsk coal ash, 3:25675
BOILERS/DESIGN
Boiler for an 800 MW power block fired by Ekibastuz coal, 3:26165
Improvement of the design of Type P-57 boiler relying on the experience of its operation at the troitskaya district power station, 3:26164
Newly developed UTR type marine reheat boiler, 3:26589
Selection of tube spacings of gastight enclosures of convective shafts of high-capacity boiler units, 3:26161
BOILERS/EFFICIENCY
Experimental investigation of the effect of regime factors on the economic efficiency of the TP-230B boiler simultaneously burning anthracite fines and residual oil, 3:26170
BOILERS/EROSION
Effect of regime parameters of boiler operation on abrasive properties of Ekibastuz coal ash, 3:26167
BOILERS/FOULING
Prevention of fouling in waste-fired vessels (In German), 3:26151 (AED-Conf-77-195-006)
BOILERS/FUEL SUBSTITUTION
Boiler burner design criteria for retrofit with low-Btu gases, 3:26778 (CONF-770885-1)
Characteristics of solvent refined coal: dual register burner tests. Final report, 3:25711 (EPRI-FP-628)
BOILERS/MATHEMATICAL MODELS
Mathematical model of a direct-flow boiler with stream heating, 3:26162
BOILERS/OPERATION
Experience of operation and results of tests of TP-100 and TP-100A boilers with open-loop pulverized fuel systems designed by tckti, 3:26140
Ways to improve the technical level of operation of Ekibastuz coal-fired boilers, 3:26169
BOILERS/PERFORMANCE
Experience of operation and results of tests of TP-100 and TP-100A boilers with open-loop pulverized fuel systems designed by tckti, 3:26140
BOILERS/RELIABILITY
Flow stability in heated channels in the transcritical region of the parameters of state, 3:26178
BOILERS/RETROFITTING
Boiler burner design criteria for retrofit with low-Btu gases, 3:26778 (CONF-770885-1)
Interactions among the National Energy Plan and the President's Environmental Message: the Coal Conversion Regulatory Program, 3:26516 (TID-28130)
BOILERS/SERVICE LIFE
Effect of temperature pulsations of the lower radiant section tubes on their service life, 3:26171
BOILERS/SIMULATION
Testing and evaluation of MHD materials and substructures. Quarterly technical progress report, January-March 1977, 3:26538 (FE-2246-3(Rev.A))
BOILERS/TEMPERATURE EFFECTS
Effect of temperature pulsations of the lower radiant section tubes on their service life, 3:26171
BOILERS/TUBES
Effect of temperature pulsations of the lower radiant section tubes on their service life, 3:26171
BOILING WATER REACTORS
See BWR TYPE REACTORS
BOLTS
See FASTENERS
BONE TISSUES/RADIONUCLIDE KINETICS
Bone-seeking radionuclides: an in vivo study of factors affecting skeletal uptake, 3:26972
BONNER SPHERE DETECTORS/DATA ANALYSIS
Least-squares technique for extracting neutron spectra from Bonner sphere data, 3:26828
BOOTSTRAP MODEL/TOTAL CROSS SECTIONS
Rising cross section and the multi-Pomeron bootstrap, 3:27286
BOREHOLES
Permeability from single and multiple detonations in boreholes, 3:25702
BOREHOLES/ACOUSTIC TESTING
Iterative reconstruction of underground refractive index distributions from cross-borehole transmission data, 3:27006 (UCRL-52348)
BOREHOLES/MAGNETIC SURVEYS
Iterative reconstruction of underground refractive index distributions from cross-borehole transmission data, 3:27006 (UCRL-52348)
BOROHYDRIDES/MAGNETIC RESONANCE
Optical and zero field magnetic resonance spectroscopy of inorganic molecular solids. Final report, 1 June 1975-31 May 1977, 3:26645 (AD-A-043340)
BOROHYDRIDES/OPTICAL PROPERTIES
Optical and zero field magnetic resonance spectroscopy of inorganic molecular solids. Final report, 1 June 1975-31 May 1977, 3:26645 (AD-A-043340)
BORON 11 TARGET/PROTON REACTIONS
Conditions for a boron fusion reactor in the MeV range, 3:27662
BORON NITRIDES/DIELECTRIC PROPERTIES
HPBN development, 3:26632 (SAND-782076C)
BORON NITRIDES/MECHANICAL PROPERTIES
HPBN development, 3:26632 (SAND-782076C)
BOSONS
See also INTERMEDIATE BOSONS
MESONS
BOSONS/BOUND STATE
Pulsating solitons, 3:27284

BOSONS/QUANTUM FIELD THEORY
Euclidean quantum field theory, 3:27301
BOUNDARY-VALUE PROBLEMS/NUMERICAL SOLUTION
Collocation methods for integro-differential equations, 3:27713
BREAKWATERS
See DAMS
BREEDING BLANKETS/DESIGN
ORNL fusion power demonstration study: fluid flow, heat transfer, and stress analysis considerations in the design of blankets for full-scale fusion reactors, 3:27617 (ORNL/TM-5960)
Use and performance of graphite and metal ISSECs in tokamak fusion reactors, 3:27618 (UWFDM-202)
BREEDING BLANKETS/HEAT TRANSFER
ORNL fusion power demonstration study: fluid flow, heat transfer, and stress analysis considerations in the design of blankets for full-scale fusion reactors, 3:27617 (ORNL/TM-5960)
WARD blanket assembly pre-test predictions by SUPERENERGY (LMFBR), 3:26281 (COO-2245-40TR)
BREEDING BLANKETS/HYBRID SYSTEMS
Absolute fission-rate distributions in lithium and hybrid fusion blanket assemblies, (2). Analysis and evaluation, 3:27622
BREEDING BLANKETS/HYDRAULICS
WARD blanket assembly pre-test predictions by SUPERENERGY (LMFBR), 3:26281 (COO-2245-40TR)
BREEDING BLANKETS/NEUTRON FLUX
Survey on experimental neutron physics of CTR blankets in the KFA, 3:27610 (EUR-5602)
BREEDING BLANKETS/NEUTRON TRANSPORT THEORY
TRIDENT: a new triangular mesh discrete ordinates code, 3:27616 (LA-UR-77-2511)
BREEDING BLANKETS/STRESS ANALYSIS
ORNL fusion power demonstration study: fluid flow, heat transfer, and stress analysis considerations in the design of blankets for full-scale fusion reactors, 3:27617 (ORNL/TM-5960)
BRICKS/MANUFACTURING
Production of forty percent core area flyash brick using a lignite flyash, a northern West Virginia flyash, and a western Kentucky flyash. Report No. 112, 3:25682 (NP-23088)
Study of the effect of firing conditions upon flyash structural products. Report No. 128, 3:25683 (NP-23089)
BRICKS/TESTING
Study of the effect of firing conditions upon flyash structural products. Report No. 128, 3:25683 (NP-23089)
BRIDGES (ELECTRIC)
See ELECTRIC BRIDGES
BRINES/REINJECTION
Laboratory investigations of permeability loss in sedimentary rocks (abstract), 3:26119
BRINES/ROCK-FLUID INTERACTIONS
Ore transport and deposition in the Red Sea geothermal system: a geochemical model, 3:26120
BROMODEOXYURIDINE
See BUDR
BRUCE-1 REACTOR/STEAM TURBINES
Wet steam turbines for nuclear generating stations -design and operating experience, 3:26273
BRUCE-2 REACTOR/STEAM TURBINES
Wet steam turbines for nuclear generating stations -design and operating experience, 3:26273
BRUCE-3 REACTOR/STEAM TURBINES
Wet steam turbines for nuclear generating stations -design and operating experience, 3:26273
BRUCE-4 REACTOR/STEAM TURBINES
Wet steam turbines for nuclear generating stations -design and operating experience, 3:26273
BUBBLE GROWTH/MATHEMATICAL MODELS
Bubble dynamics in a superheated liquid (LMFBR), 3:26277 (ANL-77-20)
BUDR
(Bromodeoxyuridine.)
BUDR/BIOLOGICAL EFFECTS
Cellular heredity in haploid cultures of somatic cells. Annual progress report, April 1976-July 1977, 3:26960 (COO-3110-28)
BUILDING MATERIALS
See also BRICKS
CEMENTS
CONCRETES
BUILDING MATERIALS/PHOTON TRANSPORT
Coupling of x-ray deposition to structural response. Final report, 3:27398 (AD-A-042667)
BUILDINGS
See also COMMERCIAL BUILDINGS
HOUSES
OFFICE BUILDINGS
BUILDINGS/AIR CONDITIONING
Matrix rotor fan combines heat recovery with balanced ventilation, 3:26550
BUILDINGS/ENERGY CONSERVATION
Regulations establishing energy conservation standards for new nonresidential buildings, 3:26551
BUILDINGS/SEISMIC EFFECTS
Determination of floor response spectra on the basis of the response spectrum method, 3:26449
Equivalent modal response method for seismic design of structures, 3:26454
Probable simultaneous response by the response spectrum method of analysis, 3:26455
BUILDINGS/SOLAR COOLING SYSTEMS
ERDA facilities solar design handbook, 3:26050 (LA-UR-77-186)
BUILDINGS/SOLAR HEATING SYSTEMS
ERDA facilities solar design handbook, 3:26050 (LA-UR-77-186)
BUILDINGS/SPACE HEATING
Matrix rotor fan combines heat recovery with balanced ventilation, 3:26550
BUILDINGS/THERMAL INSULATION
Resonaflex, the anticorrosive multi-purpose plate for thermal and acoustic insulation, 3:26584
BUILDINGS/THERMAL STRESSES
Steady-state stresses in concrete structures subjected to sustained and cyclically varying temperatures, 3:26363
BUILDINGS (CONTAINMENT)
See CONTAINMENT BUILDINGS
BURNERS
See also COMBUSTORS
FLUIDIZED-BED COMBUSTORS
BURNERS/PERFORMANCE TESTING
Brookhaven National Laboratory Burner-Boiler/Furnace Efficiency Test Project. Hydronic equipment findings report reference manual, 3:26777 (BNL-50644)
BURNERS/RETROFITTING
Characteristics of solvent refined coal: dual register burner tests. Final report, 3:25711 (EPRI-FP-628)
BURST CAN MONITORS
See FAILED ELEMENT MONITORS
BURST SLUG MONITORS
See FAILED ELEMENT MONITORS
BUTANOLS/COMBUSTION
Theoretical and experimental investigation of the ignition of fuel droplets, 3:26702
BUTENES/ISOMERIZATION
Laser synthetic chemistry, 3:26692 (LA-UR-77-2790)
BUTENES/OXIDATION
Bayer process for the manufacture of maleic anhydride from butenes and as a by-product of the phthalic anhydride production, 3:25786
BUTYL ALCOHOLS
See BUTANOLS
BUTYLENES
See BUTENES
BUTYRIC ALCOHOLS
See BUTANOLS
BWR TYPE REACTORS
See also DRESDEN-1 REACTOR
DRESDEN-2 REACTOR
DRESDEN-3 REACTOR
GE STANDARD REACTOR
LINGEN REACTOR
PHILIPPSBURG-1 REACTOR
PHILIPPSBURG-2 REACTOR
Energy from nuclear reactors. Pt. 3. The functioning of nuclear power plants with BWR reactors, 3:26218
Energy from nuclear reactors. Water as moderator: LWR reactors prevail. Pt. 1, 3:26219
BWR TYPE REACTORS/BLOWDOWN
Instrumenting a pressure suppression experiment for a MK I boiling water reactor: another measurements engineering challenge, 3:26444 (UCRL-52314)
BWR TYPE REACTORS/CONSTRUCTION
Nuclear power plants. Construction status report, data as of December 31, 1977 (USA), 3:26210 (NUREG-0030-78/01)
BWR TYPE REACTORS/CONTAINMENT SYSTEMS
Preliminary scaled multivent test program plan, 3:26438 (NEDO-23697)
Underground pressure suppression system for Boiling Water Reactors (BWRs), 3:26212 (UCID-17695)
BWR TYPE REACTORS/ECCS
Phases mission analysis: a review of new developments and an application, 3:26221
BWR TYPE REACTORS/FEEDWATER HEATERS
Feed water pre-heater with two steam spaces (Patent), 3:26224
BWR TYPE REACTORS/FUEL ELEMENT CLUSTERS
Fuel element assembly (Patent), 3:26223

BWR TYPE REACTORS/FUEL MANAGEMENT
Method to prolong the fuel cycle in a boiling water reactor (Patent), 3:26226
BWR TYPE REACTORS/FUEL PARTICLES
Properties and irradiation behavior of advanced oxide particle fuel, 3:26305
BWR TYPE REACTORS/FUEL POOLS
Design report and safety evaluation for high density fuel storage system. Licensing topical report, 3:26208 (NEDO-24076)
BWR TYPE REACTORS/FUEL-CLADDING INTERACTIONS
Chemical thermodynamics of the system Cs-U-Zr-H-I-O in the LWR fuel-clad gap, 3:26211 (ORNL/TM-6130)
BWR TYPE REACTORS/LOSS OF COOLANT
TECAR, a new program for LOCA analysis, 3:26448
BWR TYPE REACTORS/PRESSURE VESSELS
Boiling Water Reactor feedwater nozzle/sparger interim program report. Supplement No. 2: fracture mechanic analysis of JAERI model pressure vessel test, 3:26437 (NEDO-21480-02)
Nuclear reactor (Patent), 3:26225
Ultrasonic inspection of the spherically shaped perforated areas of light water reactor pressure vessels, 3:26214
BWR TYPE REACTORS/PRIMARY COOLANT CIRCUITS
Plant engineering experience with primary water purification plants in nuclear power stations with pressurised and boiling water reactors, 3:26216
BWR TYPE REACTORS/REACTOR COOLING SYSTEMS
Nuclear facilities. Recurrent inspections. Mechanical ultrasonic inspection. Draft, 3:26215
BWR TYPE REACTORS/REACTOR INTERNALS
Assessment of reactor internals vibration in BWR/4 and BWR/5 plants, 3:26207 (NEDO-24057)
BWR TYPE REACTORS/REACTOR NOISE
Coherence analysis of boiling water reactor noise, 3:26220
BWR TYPE REACTORS/REACTOR OPERATION
Licensed operating reactors. Operating units status report, data as of 12-31-77 (USA), 3:26209 (NUREG-0020(Vol.2)(No.1))
BWR TYPE REACTORS/SPENT FUEL STORAGE
Design report and safety evaluation for high density fuel storage system. Licensing topical report, 3:26208 (NEDO-24076)
BWR-6 TYPE REACTORS
See GE STANDARD REACTOR

C

CADMIUM/EMISSION SPECTROSCOPY
Determination of trace elements in soft, hard, and saline waters by the inductively coupled plasma, multi-element atomic emission spectroscopic (ICP-MAES) technique, 3:26664
CADMIUM/ENVIRONMENTAL TRANSPORT
Corrections and revisions to the FORTRAN IV version of the Wisconsin Hydrologic Transport Model, 3:27003 (ORNL/NSF/EATC-29)
CADMIUM/ION EXCHANGE
Cation exchange of 53 elements in nitric acid, 3:26665 (LA-7083)
CADMIUM/QUANTITATIVE CHEMICAL ANALYSIS
Fate of trace and minor constituents of coal during gasification. Final task report, 3:25641 (PB-270913)
CADMIUM/SOUND WAVES
Speed of ultrasound and thermophysical properties of the liquid metals of Sn, Cd, Bi and their binary alloys Cd-Bi and Sn-Bi, 3:26620
CADMIUM 111 TARGET/PROTON REACTIONS
Anomalous optical-model potential for sub-Coulomb protons for $89 < A < 130$, 3:27361
CADMIUM 113 TARGET/PROTON REACTIONS
Anomalous optical-model potential for sub-Coulomb protons for $89 < A < 130$, 3:27361
CADMIUM 114 TARGET/PROTON REACTIONS
Anomalous optical-model potential for sub-Coulomb protons for $89 < A < 130$, 3:27361
CADMIUM 116 TARGET/PROTON REACTIONS
Anomalous optical-model potential for sub-Coulomb protons for $89 < A < 130$, 3:27361
CADMIUM 122/ENERGY LEVELS
Decay of mass-separated ^{122}Ag to levels in ^{122}Cd (Transitions, isomeric half-life, tau, π), 3:27363 (IS-T-795)
CADMIUM ALLOYS/SOUND WAVES
Speed of ultrasound and thermophysical properties of the liquid metals of Sn, Cd, Bi and their binary alloys Cd-Bi and Sn-Bi, 3:26620
CADMIUM ISOTOPES/NUCLEAR PROPERTIES
Decay of mass-separated ^{122}Ag to levels in ^{122}Cd (Transitions, isomeric half-life, tau, π), 3:27363 (IS-T-795)
CADMIUM SULFIDE SOLAR CELLS/EFFICIENCY
Development of a thin film polycrystalline solar cell for large scale terrestrial use. First quarterly progress report, July 1, 1976-September 30, 1976, 3:25989 (DSE/2538-1)
Development of a thin film polycrystalline solar cell for large scale terrestrial use. Progress report, July 1, 1976-September 30, 1976, 3:25996 (TID-28183)
CADMIUM SULFIDE SOLAR CELLS/ENERGY GAP
Physics of InP/CdS solar cells, 3:26002
CADMIUM SULFIDE SOLAR CELLS/FABRICATION
Development of a thin film polycrystalline solar cell for large scale terrestrial use. First quarterly progress report, July 1, 1976-September 30, 1976, 3:25989 (DSE/2538-1)
Development of a thin film polycrystalline solar cell for large scale terrestrial use. Progress report, July 1, 1976-September 30, 1976, 3:25996 (TID-28183)
CADMIUM SULFIDE SOLAR CELLS/SPECTRALLY SELECTIVE SURFACES
Cadmium stannate selective optical films for solar energy applications. Semi-annual progress report 1 Jan-30 Jun 75, 3:25994 (PB-273038)
CAFB PROCESS
(Chemically active fluidized bed process.)
CAFB PROCESS/AIR POLLUTION ABATEMENT
Advanced fossil fuel and the environment: an executive report, 3:26192 (EPA-600/9-77-013)
CALCITE/CHEMICAL REACTION KINETICS
Kinetics of endothermic decomposition reactions. II. Effects of the solid and gaseous products, 3:26672
CALCITE/ISOTOPE RATIO
Iotopic evidence for local derivation of strontium in deep-seated, fracture-filling calcite from granitic rocks in drill hole GT-2, Los Alamos Scientific Laboratory Dry Hot Rock Program, 3:26103
CALCIUM/OXIDATION
Low-temperature oxidation of calcium by water vapor, 3:26681
CALCIUM 40 TARGET/OXYGEN 16 REACTIONS
Energy dependence of the distribution of reaction strength in the $^{16}O + {}^{40}Ca$ collisions (75 MeV), 3:27351 (ANL-77-60)
Fusion of $^{16}O + {}^{40}Ca$ (45 to 63 MeV: cross sections), 3:27350 (ANL-77-60)
Inelastic scattering of ^{16}O on even-Ca isotopes (56, 60 MeV: angular distributions), 3:27352 (ANL-77-60)
CALCIUM 40 TARGET/PROTON REACTIONS
Elastic scattering of 1-GeV protons by nuclei, 3:27127
CALCIUM 42 TARGET/OXYGEN 16 REACTIONS
Inelastic scattering of ^{16}O on even-Ca isotopes (56, 60 MeV: angular distributions), 3:27352 (ANL-77-60)
CALCIUM 44 TARGET/OXYGEN 16 REACTIONS
Inelastic scattering of ^{16}O on even-Ca isotopes (56, 60 MeV: angular distributions), 3:27352 (ANL-77-60)
CALCIUM 48 TARGET/OXYGEN 16 REACTIONS
Inelastic scattering of ^{16}O on even-Ca isotopes (56, 60 MeV: angular distributions), 3:27352 (ANL-77-60)
CALCIUM FLUORIDES/CHEMICAL RADIATION EFFECTS
Trapping and stabilization of hydrogen atoms in intracrystalline voids. Defected calcium fluorides and Y zeolite surfaces (γ rays), 3:26698
CALCIUM OXIDES/CATALYTIC EFFECTS
Homogeneous catalytic hydrocracking processes for conversion of coal to liquid fuels: basic and exploratory research. Quarterly report No. 7, May 1, 1977-July 31, 1977, 3:25653 (FE-2202-21)
CALCIUM OXIDES/REGENERATION
Preparation of a coal conversion systems technical data book. Project 8979 quarterly report, May 1-July 31, 1977, 3:25633 (FE-2286-20)
Regeneration of lime-based sorbents in a kiln with solid reductants, 3:25710 (BNL-23765)
CALDER HALL A-1 REACTOR
Birth of Calder Hall, 3:26258
CALHOUN-1 REACTOR/NEUTRON DOSIMETRY
Neutron dose monitoring using a multiple lithium fluoride TLD badge, 3:26462
CALHOUN-2 REACTOR/NEUTRON DOSIMETRY
Neutron dose monitoring using a multiple lithium fluoride TLD badge, 3:26462
CALIFORNIA/ENERGY SOURCE DEVELOPMENT
Western States energy resource development update 1976, 3:26503
CALIFORNIA/ENERGY SOURCES
Energy Resources Conservation and Development Commission 1978/79 budget, 3:26502
CALIFORNIA/NATURAL GAS FIELDS
Outer Continental Shelf Sale No. 35: problems selecting and evaluating land to lease, 3:25806 (EMD-77-19)
CALIFORNIA/OIL FIELDS
Outer Continental Shelf Sale No. 35: problems selecting and evaluating land to lease, 3:25806 (EMD-77-19)

CALIFORNIA/RESIDENTIAL SECTOR
Supplement to "Technical Documentation of Staff Procedures for Estimating Peak Demand", 3:26527
CALIFORNIA/RESOURCE CONSERVATION
Energy Resources Conservation and Development Commission 1978/79 budget, 3:26502
CALIFORNIA/WATER RESOURCES
Water resources appraisal for hydroelectric licensing, Kern River Basin, California, 3:25978 (TID-28173)
CALIFORNIUM 252/SPONTANEOUS FISSION
Number and spectra of neutrons for specified fragments in spontaneous fission of ^{252}Cf, 3:27383
CALIPER LOGGING/PERFORMANCE
Use of borehole geophysical methods in determining in situ bulk densities and water contents in unconsolidated materials. Final report, 3:26844 (AD-A-046114)
CAMERAS/PERFORMANCE
Marco image converter camera. Period covered: July-September 1977, 3:26838 (MHSMP-77-50)
CANCER
See NEOPLASMS
CANDU TYPE REACTORS/HEALTH HAZARDS
Occupational doses in the Ontario Hydro nuclear power program, 3:26463
CANDU TYPE REACTORS/PRESSURE TUBES
Non-rotating device for in-situ inspection of pressure tube in CANDU nuclear reactors, 3:26271
CANNIKIN EVENT/BIOLOGICAL EFFECTS
Marine invertebrates in rocky intertidal communities, 3:26926 (TID-26712)
CANNIKIN EVENT/ENVIRONMENTAL EFFECTS
Aquatic ecology, 3:26924 (TID-26712)
Ecology of marine algae (Prasiola, Rhodochorton, Porphyra, Ulothrix, Alaria, Fucus), 3:26925 (TID-26712)
CANONICAL EQUATIONS
See DIFFERENTIAL EQUATIONS
CARBENES/CHEMICAL REACTION KINETICS
Unsaturated carbenes from primary vinyl triflates. IX. Intramolecular rearrangement via free carbenes, 3:26685
CARBON
See also ACTIVATED CARBON
CARBON/CHEMICAL REACTIONS
Steam reforming of hydrocarbons on alkali polyaluminate catalysts. II. Reactivity of deposited carbon, 3:25785
CARBON/COMBUSTION PROPERTIES
Burning rate of carbon in fluidized beds, 3:25716
CARBON/DEPOSITION
Effect of carbon deposition on porosity and reactivity of a lignite char, 3:25666
CARBON/EMISSIVITY
Infrared emissivities of micron-sized particles of C, MgO, Al_2O_3, and ZrO_2. Final report, 3:26636 (AD-A-042144)
CARBON/FLUIDIZED-BED COMBUSTION
Burning rate of carbon in fluidized beds, 3:25716
CARBON/HEAVY ION REACTIONS
Proton and pion spectra at large angles in relativistic heavy-ion collisions (800 MeV/N), 3:27332 (LBL-670)
CARBON/ION COLLISIONS
Role of K-shell vacancies in determining charge-state fractions for heavy ions emerging from solids, 3:27077
CARBON/ION-ATOM COLLISIONS
Alignment of helium excited by thin carbon foils (50-500 keV He^+), 3:27075
Radiative lifetimes of the low-lying levels of Na-like copper, 3:27080
CARBON/MASS SPECTROSCOPY
Carbon analysis in fly ash, 3:25685
CARBON/QUANTITATIVE CHEMICAL ANALYSIS
Method and equipment for the continuous determination of the content of burnable components in powder form bulk goods (Patent), 3:26663
CARBON 12/ENERGY-LEVEL TRANSITIONS
Pair decay of the 7.65-MeV level of ^{12}C, 3:27330
CARBON 12/HYPERNUCLEI
Possibility of charmed hypernuclei, 3:27228
CARBON 12 REACTIONS/COMPOUND-NUCLEUS REACTIONS
High-spin states in ^{70}Ge, 3:27358
Mechanisms for Li and Be production in the $^{14}N + {}^{12}C$ reaction, 3:27336
CARBON 12 REACTIONS/ELASTIC SCATTERING
Low energy elastic scattering from ^{28}Si targets using projectiles with $9 \leq$ or $= A \leq$ or $= 18$, 3:27344
CARBON 12 REACTIONS/FISSION
Measurement of the effective widths of excited states of heavy nuclei ($Z=98$, 100, 102) by means of the blocking effect, 3:27382
CARBON 12 REACTIONS/INELASTIC SCATTERING
Folding model description of heavy ion inelastic scattering, 3:27328
CARBON 12 TARGET/NEUTRON REACTIONS
Coherent dissociation of neutrons on nuclei at 100-300 GeV/c, 3:27123
CARBON 12 TARGET/OXYGEN 16 REACTIONS
Folding model description of heavy ion inelastic scattering, 3:27328
CARBON 12 TARGET/PHOTONUCLEAR REACTIONS
Pre-equilibrium particle decay in the photonuclear reactions, 3:27327
CARBON 12 TARGET/PION MINUS REACTIONS
Study of pion-absorption mechanisms in ^4He and other nuclei, 3:27323
CARBON 12 TARGET/PION PLUS REACTIONS
Measurement of the $^{12}C(\pi^+, \pi^+ + p)^{11}B$ reaction cross section (Preliminary results, 100 and 130 MeV), 3:27333 (ORO-4043-37)
Properties of inclusive (π^+,π^0) reactions in nuclei, 3:27334
Study of pion-absorption mechanisms in ^4He and other nuclei, 3:27323
CARBON 12 TARGET/PROTON REACTIONS
Energy dependence of the pseudorapidity distributions in proton-nucleus collisions between 50 and 200 GeV/c, 3:27124
Pair decay of the 7.65-MeV level of ^{12}C, 3:27330
CARBON 13/NUCLEAR MAGNETIC RESONANCE
Carbon magnetic resonance spectroscopy on carbon-13-labeled uracil in 5S ribonucleic acid, 3:26686
CARBON 14/BETA-MINUS DECAY
Beta decays and related processes in the $A = 14$ nuclei, 3:27326
CARBON DIOXIDE/CHEMICAL REACTION KINETICS
Mechanism of methanol synthesis from carbon dioxide and hydrogen. III. Determination of rates of individual stages using ^{14}CO, 3:25967
CARBON DIOXIDE/DENSITY
Roscoe manual. Volume 14B. Midlatitude density profiles of selected atmospheric species. Final report, 2 March 1974-28 February 1975, 3:26852 (AD-A-043499)
CARBON DIOXIDE/EQUILIBRIUM
Preparation of a coal conversion systems technical data book. Project 8979 quarterly report, May 1-July 31, 1977 (NH_3-CO_2-H_2S-H_2O, cyclohexane-H_2O), 3:25633 (FE-2286-20)
CARBON DIOXIDE/FLUORESCENCE
Laboratory investigation of infrared fluorescence of CO_2, HAES report number 60. Final report 1 AGusut 1975-31 December 1976, 3:26853 (AD-A-043524)
CARBON DIOXIDE/REMOVAL
Corrosion control in gas processing plants which remove CO_2 and H_2S (Monoethanolamine), 3:25768
CARBON DIOXIDE/SEPARATION PROCESSES
Economics of carbon dioxide removal, 3:26019 (COO/2991-19)
CARBON DIOXIDE ACCEPTOR PROCESS/MAINTENANCE
Review and evaluation of failures, maintenance, and operability data for CO_2 Acceptor Plant mechanical equipment, 3:25640 (MIT-78-TR3)
CARBON DIOXIDE ACCEPTOR PROCESS/PILOT PLANTS
Review and evaluation of failures, maintenance, and operability data for CO_2 Acceptor Plant mechanical equipment, 3:25640 (MIT-78-TR3)
CARBON DIOXIDE ACCEPTOR PROCESS/WEAR
Review and evaluation of failures, maintenance, and operability data for CO_2 Acceptor Plant mechanical equipment, 3:25640 (MIT-78-TR3)
CARBON DIOXIDE LASERS
Power lasers for thermonuclear fusion, 3:27688
CARBON DIOXIDE LASERS/BEAM MONITORING
Universal monitor for CO_2 lasers (Profile, pulse shape, and power), 3:26736 (BDX-613-1907)
CARBON DIOXIDE LASERS/BIBLIOGRAPHIES
Carbon dioxide lasers. Volume 2. 1975-May 1976 (a bibliography with abstracts). Report for 1975-May 1976, 3:26738 (NTIS/PS-77/0709)
Carbon dioxide lasers. Volume 3. June 1976-August 1977 (a bibliography with abstracts). Report for June 1976-August 1977, 3:26739 (NTIS/PS-77/0710)
CARBON DIOXIDE LASERS/ELECTRIC DISCHARGES
Analysis of continuous electron gun pre-ionized electric laser discharges, 3:26763
Pulsed electrical-discharge CO_2 laser with ionization of the gas mixture by ultraviolet radiation at atmospheric pressure, 3:26750
CARBON DIOXIDE LASERS/GAIN
Analysis of continuous electron gun pre-ionized electric laser discharges, 3:26763
CARBON DIOXIDE LASERS/MIXING
Use of metal-oxide-metal diode for multiplying and mixing laser frequencies within the near infrared and the visible range (CO_2 and He--Ne lasers), 3:26755

CARBON DIOXIDE LASERS/MODULATION
Self-modulation of lasers by means of nonlinear absorbing filters, 3:26761
CARBON IONS/BALMER LINES
Intensity inversion in the Balmer spectrum of C^{5+}, 3:27533
CARBON IONS/POPULATION INVERSION
Intensity inversion in the Balmer spectrum of C^{5+}, 3:27533
CARBON IONS/ULTRAVIOLET SPECTRA
Intensity inversion in the Balmer spectrum of C^{5+}, 3:27533
CARBON MONOXIDE LASERS/ENERGY TRANSFER
Energy transfer in lasers. Final technical report, 3:26730 (AD-A-043808)
CARBON OXYSULFIDE/CATALYTIC EFFECTS
Laser synthetic chemistry, 3:26692 (LA-UR-77-2790)
CARBON STEELS/COATINGS
Study of plant metallurgical requirements for low-Btu gasification of coal for electric power generation, 3:25629 (FE-1545-39)
CARBON STEELS/COMPATIBILITY
Compatibility testing of vitrified waste forms, 3:25936 (DP-MS-77-115)
CARBONATE ROCKS/CHEMICAL COMPOSITION
Use of neutron-gamma logging data normalized from readings in a reference borehole to estimate the volume water content of carbonate rocks, 3:27019 (UCRL-Trans-11309)
CARBONATE ROCKS/HYDROTHERMAL SYNTHESIS
Experiments of syntheses of carbonate minerals by thermal diffusion in porous media, 3:26122
CARBONATE ROCKS/NEUTRON-GAMMA LOGGING
Use of neutron-gamma logging data normalized from readings in a reference borehole to estimate the volume water content of carbonate rocks, 3:27019 (UCRL-Trans-11309)
CARBONATE ROCKS/POROSITY
Use of neutron-gamma logging data normalized from readings in a reference borehole to estimate the volume water content of carbonate rocks, 3:27019 (UCRL-Trans-11309)
CARBONYL SULFIDE
See CARBON OXYSULFIDE
CARBONYLS/CHEMICAL PREPARATION
Synthesis and characterization of $[(eta^5\text{-}C_5H_5)V(CO)_3H]^-$, a new anionic vanadium carbonyl hydride, and a study of its reduction reaction with organic halides. Observation of a free-radical chain process having an extremely rapid metal-to-carbon hydrogen transfer step, 3:26676
CARBONYLS/CHEMICAL REACTIONS
Synthesis and characterization of $[(eta^5\text{-}C_5H_5)V(CO)_3H]^-$, a new anionic vanadium carbonyl hydride, and a study of its reduction reaction with organic halides. Observation of a free-radical chain process having an extremely rapid metal-to-carbon hydrogen transfer step, 3:26676
CARCINOGENS/BIBLIOGRAPHIES
Literature survey of bacterial, fungal, and Drosophila assay systems used in the evaluation of selected chemical compounds for mutagenic activity, 3:26994 (ORNL/EMIC-9)
CARCINOGENS/BIOASSAY
Literature survey of bacterial, fungal, and Drosophila assay systems used in the evaluation of selected chemical compounds for mutagenic activity, 3:26994 (ORNL/EMIC-9)
CARCINOGENS/METABOLISM
Chemical production of excited states: adventitious biological chemiluminescence of carcinogenic polycyclic aromatic hydrocarbons, 3:26946 (COO-3277-44)
CARCINOGENS/SAMPLING
Development of sampling and analytical methods for carcinogens. Progress report, January 1-September 30, 1976, 3:26997 (LA-7058-PR)
CARCINOMAS/RADIOINDUCTION
Ultrastructural characteristics of advanced radiation-induced adenocarcinoma in the small intestine of the rat (X radiation), 3:26986 (CONF-770504-)
CARCINOMAS/ULTRASTRUCTURAL CHANGES
Ultrastructural characteristics of advanced radiation-induced adenocarcinoma in the small intestine of the rat (X radiation), 3:26986 (CONF-770504-)
CASTINGS/SOLIDIFICATION
Use of general purpose software in casting solidification simulation, 3:26597
CATALYSIS/CHEMICAL PREPARATION
Flash pyrolysis coal liquefaction process development. Monthly report, July 1977, 3:25654 (FE-2244-15)
CATALYSTS
Use of a third-order Latin square in selecting hydrocracking catalysts, 3:25775
CATALYSTS/CHEMICAL PREPARATION
Catalyst development for coal liquefaction. Annual report, July 1, 1976-June 30, 1977, 3:25657 (FE-2335-13)
Catalyst development for coal liquefaction. Interim report, July-September 1977, 3:25658 (FE-2335-16)
CATALYSTS/COMPARATIVE EVALUATIONS
Catalyst development for coal liquefaction. Annual report, July 1, 1976-June 30, 1977, 3:25657 (FE-2335-13)
CATALYSTS/DEACTIVATION
Gas generator research and development BI-GAS Process. 76th monthly progress report, December 1977, 3:25627 (FE-1207-40)
Hydrocarbon cracking on amorphous and zeolithic cracking catalysts, 3:25764 (NP-22646)
Operating experience with the IGT cold-gas recycle methanation process in the HYGAS pilot plant, 3:25623 (CONF-771092-9)
CATALYSTS/EVALUATION
Clean solid and liquid fuels from coal. Quarterly progress report, July-September 1977, 3:25665 (TID-28167)
CATALYSTS/PERFORMANCE TESTING
Catalyst development for coal liquefaction. Interim report, July-September 1977, 3:25658 (FE-2335-16)
CATALYSTS/REGENERATION
Conditions for regenerating an iron-molybdenum-tungsten catalyst used in ammonia synthesis, 3:25970
CATALYSTS/SERVICE LIFE
Gas generator research and development BI-GAS Process. 76th monthly progress report, December 1977, 3:25627 (FE-1207-40)
CATALYTIC CRACKING
See also HYDROCRACKING
CATALYTIC CRACKING/CATALYSTS
Hydrocarbon cracking on amorphous and zeolithic cracking catalysts, 3:25764 (NP-22646)
CATTLE
See also COWS
CATTLE/ENERGY CONSUMPTION
Energy use in the dairy industry (report No. 25), 3:26529 (NP-23050)
CATTLE/PARASITES
Ultrastructure of cryptosporidia in the Bovine species, 3:26975 (CONF-770504-)
CAVITIES
See also BOREHOLES
CAVITIES/STRESSES
Laboratory investigation of rock cavity reinforcement. Final report, 17 September 1974-16 March 1976, 3:26851 (AD-A-043398)
CE ENTRAINED FUEL PROCESS/MATERIALS
Study of plant metallurgical requirements for low-Btu gasification of coal for electric power generation, 3:25629 (FE-1545-39)
CE STANDARD REACTOR
(Prior to 1975, PWR/80 TYPE REACTORS was used.)
C-E balances the benefits against the costs, 3:26236
CE STANDARD REACTOR/LOSS OF COOLANT
Method for the analysis of blowdown induced forces in a reactor vessel, 3:26433 (CENPD-252-NP)
CELL CULTURES/HAMSTERS
Comparative metabolism of benzo(a)pyrene in rodent liver and embryonic cells in tissue culture, 3:26995 (CONF-771147-2)
CELL CYCLE/MATHEMATICAL MODELS
Mathematical model of the connection between the DNA karyogram and the cell cycle. Part 1. Derivation of the DNA frequency distribution from the duration of the individual phases of the cell cycle, 3:26964 (LA-tr-78-3)
CELL FLOW SYSTEMS
Automated cancer-cell sorting and analysis. Progress report, June 1-November 30, 1977, 3:26961 (LA-7076-PR)
Clustering algorithm for mixtures of monotone densities, 3:26962 (LA-7120-MS)
CELL MEMBRANES/BIOCHEMISTRY
Membrane biogenesis: an application of biochemistry and cytochemistry to electron microscopy, 3:26953 (CONF-770504-)
CELL MEMBRANES/ELECTRON MICROSCOPY
Membrane biogenesis: an application of biochemistry and cytochemistry to electron microscopy, 3:26953 (CONF-770504-)
CELL MEMBRANES/LABELLING
Spin label studies on membranes and the aqueous zones of membrane enclosures. Progress report, period covered: August 1976 to the present, 3:26959 (COO-2223-25)
CELL MEMBRANES/MORPHOLOGICAL CHANGES
Splenic remodeling of red cell surfaces, 3:26963
CELL MEMBRANES/PIGMENTS
Annual progress report, September 1, 1976-November 30, 1977 (Chromophores in photosynthetic membranes and reaction centers of Rhodopseudomonas sp.), 3:26945 (COO-3162-36)
CELL NUCLEI/MEASURING METHODS
Applications of interference microscopy for measurements on the cell nucleus in comparison with impulse cytophotometry, 3:26966 (LA-tr-78-4)
CELL WALL/GROWTH
Studies on the control of cell wall extension. Progress report, July 1, 1976-September 1, 1977, 3:26949 (RLO/2225/T19-43)
CELLS (ANIMAL)
See ANIMAL CELLS

CELLS (BACTERIAL)
See BACTERIA
CELLS (PLANT)
See PLANT CELLS
CELLULOSE/ANAEROBIC DIGESTION
Biochemistry of methanogeness, 3:26026 (SRO-0888-2)
Multidisciplinary research program directed toward utilization of solar energy through bioconversion of renewable resources. Progress report, 3:26023 (SRO-0888-2)
CELLULOSE/ENZYMATIC HYDROLYSIS
Cellulose, food and energy, 3:26021 (LBL-5275)
CEMENTS/LEACHING
Leaching behavior of strontium-90 in cement composites, 3:25942
CENTRAL RECEIVERS/COMPUTER CALCULATIONS
Educated ray trace approach to solar tower optics, 3:26037
CENTRAL RECEIVERS/INFRARED THERMOGRAPHY
Infrared television measurement of heliostat images, 3:26075
CENTRAL RECEIVERS/OPTICS
Educated ray trace approach to solar tower optics, 3:26037
CENTRAL RECEIVERS/SOLAR FLUX
Infrared television measurement of heliostat images, 3:26075
CEPHEIDS/HERTZSPRUNG-RUSSELL DIAGRAM
Cepheid pulsation theory and multiperiodic Cepheid variables (Review), 3:27022
CEPHEIDS/MASS
Cepheid pulsation theory and multiperiodic Cepheid variables (Review), 3:27022
CEPHEIDS/PULSATIONS
Cepheid pulsation theory and multiperiodic Cepheid variables (Review), 3:27022
CEPHEIDS/VARIATIONS
Cepheid pulsation theory and multiperiodic Cepheid variables (Review), 3:27022
CERAMICS/CREEP
Non-linear least-square fitting approach for determining activation energies for high temperature creep (abstract), 3:26110
CERAMICS/MATERIALS TESTING
Ceramic technology readiness program. Third monthly technical progress report, November 28, 1977-January 1, 1978, 3:26144 (FE/2664-3)
CERAMICS INDUSTRY/ENERGY CONSERVATION
Energy efficiency improvement target for SIC 32: stone, clay, and glass products. Volume 1. Draft report. Research report, 3:26562 (PB-269880)
Energy efficiency improvement target for SIC 32: stone, clay, and glass products. Volume 2. Draft report. Appendices. Research report, 3:26563 (PB-269881)
Energy efficiency improvement target for SIC 32: stone, clay, and glass products. Volume 3. Draft report. Appendices. Research report, 3:26564 (PB-269882)
Energy efficiency improvement target for SIC 32: stone, clay, and glass products. Volume 4. Final report. Research report, 3:26565 (PB-269883)
CERIUM COMPOUNDS/KNIGHT SHIFT
Systematics in the Knight shift of rare-earth monopnictides, 3:26600
CESIUM/ATOM-MOLECULE COLLISIONS
Ionizing collisions of cesium and potassium atoms with water, 3:27066
CESIUM/FORBIDDEN TRANSITIONS
Calculation of parity-nonconserving effects in forbidden M1 transitions in cesium, 3:27054
CESIUM/ION-ATOM COLLISIONS
Collisions of H^- ions and fast H^0 atoms in a Cs vapor target, 3:27068
CESIUM 134/ENVIRONMENTAL TRANSPORT
Radionuclide transport (Hanford terrestrial ecosystems), 3:25948 (PNL-2253)
CESIUM 137/ENVIRONMENTAL EFFECTS
Radionuclides in air, water, and biota (^{40}K, ^{7}Be, ^{137}Cs), 3:26934 (TID-26712)
CESIUM 137/ENVIRONMENTAL TRANSPORT
Ecology of Hanford 200 Area and 1976 radionuclide inventory, 3:25944 (PNL-2253)
Radionuclide transport (Hanford terrestrial ecosystems), 3:25948 (PNL-2253)
CESIUM 137/RADIATION MONITORING
Revegetation of a waste disposal site in the 200 areas of the Hanford Reservation, 3:26908 (PNL-2454)
CESIUM CHLORIDES/CRYSTAL STRUCTURE
Breakdown of the "white noise approximation" in the Moessbauer relaxation spectra: The case of $Cs_2NaYbCl_6$, 3:26653
CHALCOPYRITE/GEOLOGIC STRATA
Geochemical dispersion at the Mother Lode Mine near Kennicott, Alaska, 3:27015 (LA-6987-MS)
CHARGED PARTICLES/PARTICLE PRODUCTION
Inclusive charged-particle production in neutron-nucleus collisions, 3:27121
CHARGED-PARTICLE TRANSPORT
(For diffusion or transmission of charged particles in material media.)
CHARGED-PARTICLE TRANSPORT/COMPUTER CODES
A boltzmann transport code for ion penetration in matter. Memorandum report, 3:27399 (AD-A-043502)
CHARGED-PARTICLE TRANSPORT/MOMENTS METHOD
Moment method for calculating the transport of energetic charged particles in hot plasmas, 3:27522
CHARGING MACHINES (REACTOR)
See REACTOR CHARGING MACHINES
CHARGING (REACTOR)
See REACTOR FUELING
CHARM PARTICLES
See also D RESONANCES
CHARM PARTICLES/BOUND STATE
Possibility of charmed hypernuclei, 3:27228
CHARM PARTICLES/DECAY
Phenomenological model for charmed meson decay, 3:27221
CHARM PARTICLES/LEPTONIC DECAY
Charmed-meson decay in the massive-quark model, 3:27192
Dimuon distribution from production of heavy particles in high-energy ν and nu-bar reactions, 3:27187
CHARM PARTICLES/PAIR PRODUCTION
Quantum chromodynamics predictions for the associated production of charm by neutrinos, 3:27186
CHARM PARTICLES/PARTICLE PRODUCTION
Dimuon distribution from production of heavy particles in high-energy ν and nu-bar reactions, 3:27187
Inclusive baryon production in e^+e^- annihilation, 3:27103
Possible mechanism of direct production of leptons in pN collisions, 3:27237
Search for a new short-lived particle in collisions of 70 GeV/c protons with emulsion nuclei, 3:27118
Study of final states in $\pi^- N \rightarrow \mu^+ \mu^-$ + hadrons at 225 GeV (Cross sections), 3:27144
Violation of scaling and the production of charmed particles in neutrino experiments, 3:27201
CHARMONIUM/ANNIHILATION
Corrections to the two-gluon annihilation rates of paracharmonium states, 3:27177
CHARMONIUM/BOUND STATE
Charmonium, 3:27163
CHARMONIUM/DECAY
Charmonium, 3:27163
Simple symmetry breaking in a chiral SU(4) x SU(4) model of pseudoscalar mesons, 3:27199
CHARMONIUM/EMISSION SPECTRA
Charmonium, 3:27163
CHARMONIUM/ENERGY LEVELS
Charmonium, 3:27163
CHARMONIUM/ENERGY TRANSFER
Charmonium, 3:27163
CHARMONIUM/HADRONS
Hadrons (usual and newly discovered) in gauge theories a dream, 3:27213
CHARMONIUM/SYMMETRY BREAKING
Simple symmetry breaking in a chiral SU(4) x SU(4) model of pseudoscalar mesons, 3:27199
CHARS/CHEMICAL COMPOSITION
New method for sulphur concentration measurements in coal and char, 3:25670
CHARS/CHEMICAL REACTIONS
Effect of carbon deposition on porosity and reactivity of a lignite char, 3:25666
CHARS/ELECTRIC CONDUCTIVITY
Electrical conductivity of coal and coal char, 3:25674
CHARS/PNEUMATIC TRANSPORT
Flash pyrolysis coal liquefaction process development. Monthly report, July 1977, 3:25654 (FE-2244-15)
CHARS/POROSITY
Effect of carbon deposition on porosity and reactivity of a lignite char, 3:25666
CHARS/SURFACE AREA
Effect of carbon deposition on porosity and reactivity of a lignite char, 3:25666
CHEMICAL ANALYSIS
See also FLUORESCENCE SPECTROSCOPY
MICROANALYSIS
MULTI-ELEMENT ANALYSIS
QUANTITATIVE CHEMICAL ANALYSIS
CHEMICAL ANALYSIS/AUTOMATION
Automation of the national water quality laboratories, U.S. Geological Survey 2: design concepts for achievement of automation objectives (Computer systems), 3:27017 (UCRL-52295(Pt.2))
CHEMICAL ANALYSIS/ON-LINE SYSTEMS
Environmental assessment of the HYGAS Process. Project No. 9025 monthly progress report, August 1-August 31, 1977, 3:25637 (FE-2433-18)

CHEMICAL EFFLUENTS/ENVIRONMENTAL TRANSPORT
Assessment methodology for chemical effluents, 3:26874 (BNWL-2219)
New measure of association for spatial variables. Technical report No. 7, 3:26876 (COO-2874-16)
Priori predictive methods of assessing health effects of chemicals in the environment, 3:26878 (LBL-6372)
CHEMICAL EFFLUENTS/HEALTH HAZARDS
Assessment methodology for chemical effluents, 3:26874 (BNWL-2219)
Environmental assessment methodology for the nuclear fuel cycle, 3:26873 (BNWL-2219)
Priori predictive methods of assessing health effects of chemicals in the environment, 3:26878 (LBL-6372)
CHEMICAL EXPLOSIVES
See also TATB
CHEMICAL EXPLOSIVES/DETONATIONS
Shock-wave evolution in chemically reacting solid (PBX-9404), 3:26848
Thermal ignition time for homogeneous explosives involving two parallel , 3:26847
CHEMICAL EXPLOSIVES/PERFORMANCE
Properties of benzotrifuroxan, 3:26846 (UCRL-52353)
CHEMICAL EXPLOSIVES/SHOCK WAVES
Shock-wave evolution in chemically reacting solid (PBX-9404), 3:26848
CHEMICAL FEEDSTOCKS
See also PETROCHEMICALS
CHEMICAL FEEDSTOCKS/COMPARATIVE EVALUATIONS
Economics of naphthe versus gas cracking, 3:25831
CHEMICAL FEEDSTOCKS/ULTRAFILTRATION
Current status of an ERDA project "permselective membrance control of algal and wood digesters for increased production and chemicals recovery", 3:26009 (COO/2991-19)
CHEMICAL INDUSTRY/ENERGY CONSERVATION
Scenarios chemical technology (In German), 3:26555 (BMFT-FB-T-77-01)
CHEMICAL INDUSTRY/POLLUTION CONTROL
Waste processing and pollution in the chemical and petrochemical industries. Volume 2. 1975-August 1977 1977 (a bibliography with abstracts). Report for 1975-August 1977, 3:25797 (NTIS/PS-77/0706)
CHEMICAL LASERS
Power lasers for thermonuclear fusion, 3:27688
CHEMICAL LASERS/COST
Simple model of a chain-reaction pulsed HF laser. Interim report, 3:26728 (AD-A-043319)
CHEMICAL LASERS/GAS GENERATORS
Solid gas generators for chemical lasers, 3:26727 (AD-A-042674)
CHEMICAL LASERS/OPERATION
Chemical hf laser operating at high pressure of the active medium, 3:26769
Numerical method for two-dimensional steady-state chemical laser calculations, 3:26765
CHEMICAL LASERS/PERFORMANCE
Simple model of a chain-reaction pulsed HF laser. Interim report, 3:26728 (AD-A-043319)
CHEMICAL LASERS/POWER
Numerical method for two-dimensional steady-state chemical laser calculations, 3:26765
CHEMICAL LASERS/REACTION KINETICS
Fundamental kinetic rate processes occurring in polyatomic vibrational lasers. Final technical report 11 Nov 76-11 Jun 77, 3:26733 (AD-A-046014)
Review of rate coefficients in the D_2-F_2 chemical laser system. Interim report, 3:26731 (AD-A-043812)
CHEMICAL LASERS/RESEARCH PROGRAMS
Molecular and chemical laser systems. Final report, 4 February 1974-30 June 1977, 3:26729 (AD-A-043339)
CHEMICAL LASERS/REVIEWS
Review of rate coefficients in the D_2-F_2 chemical laser system. Interim report, 3:26731 (AD-A-043812)
CHEMICAL LASERS/STABILITY
Temporal stability of single-line cw HF chemical laser with unstable resonator. Interim report, 3:26722 (AD-A-042458)
CHEMICAL REACTORS
Design and operation of air-lift, circulated, cascade dissolver systems, 3:26667 (RFP-2716)
CHEMICAL REACTORS/DESIGN
Analysis of coal hydrogasification processes. Monthly technical progress report, 1 December-31 December 1977, 3:25639 (FE-2565-10)
Biological conversion of biomass to methane, 3:26018 (COO/2991-19)
Design of a homogeneous reactor for the manufacture of chloromethanes, 3:25782
CHEMICAL REACTORS/OPTIMIZATION
Selection of the optimum height-diameter ratio to be used in low-pressure methanol synthesis, 3:25965
CHEMILUMINESCENCE
Chemical production of excited states: adventitious biological chemiluminescence of carcinogenic polycyclic aromatic hydrocarbons, 3:26946 (COO-3277-44)
CHEROKEE-1 REACTOR
Standardization facilitated by Duke's in-house capability for design and construction, 3:26235
System 80 NSSS combines proven and new features, 3:26233
World's reactor, No. 72. Cherokee/Perkins Nuclear Stations, 3:26232
CHEROKEE-1 REACTOR/CONTAINMENT
Spherical containment system has many advantages, 3:26447
CHEROKEE-1 REACTOR/REACTOR CONTROL SYSTEMS
Applying improved instrumentation and computer control systems, 3:26406
CHEROKEE-1 REACTOR/REACTOR INSTRUMENTATION
Applying improved instrumentation and computer control systems, 3:26406
CHEROKEE-1 REACTOR/SITE SELECTION
Selecting sites for ease of licensing requirements, 3:26414
CHEROKEE-2 REACTOR
Standardization facilitated by Duke's in-house capability for design and construction, 3:26235
World's reactor, No. 72. Cherokee/Perkins Nuclear Stations, 3:26232
CHEROKEE-2 REACTOR/SITE SELECTION
Selecting sites for ease of licensing requirements, 3:26414
CHEROKEE-3 REACTOR
Standardization facilitated by Duke's in-house capability for design and construction, 3:26235
World's reactor, No. 72. Cherokee/Perkins Nuclear Stations, 3:26232
CHEROKEE-3 REACTOR/SITE SELECTION
Selecting sites for ease of licensing requirements, 3:26414
CHIRAL SYMMETRY/SYMMETRY BREAKING
Pseudoparticles and massless fermions in two dimensions, 3:27158
CHLAMYDOMONAS/PHOTOSYNTHESIS
Effect of light on respiration and development of photosynthetic cells. Progress report, June 1, 1976-August 31, 1977 (Chlamydomonas, Euglena, spinach, peas), 3:26969 (COO-3231-5)
CHLORIDES/CORROSIVE EFFECTS
Corrosion of reinforced concrete (citations from the NTIS data base). Report for 1964-Nov 77, 3:26656 (NTIS/PS-77/0966)
CHLORINATED AROMATIC HYDROCARBONS/BIOLOGICAL EFFECTS
Polychlorinated biphenyls in the ecosystems, 3:26906 (TID-26712)
CHLORINE/QUANTITATIVE CHEMICAL ANALYSIS
Fate of trace and minor constituents of coal during gasification. Final task report, 3:25641 (PB-270913)
CHLORINE 37 TARGET/ALPHA REACTIONS
Low-lying states in ^{39}Ar from the ^{37}Cl(α,d)^{39}Ar reaction, 3:27345
CHLORINE IONS/PAIR PRODUCTION
Dependence of anti W on the charge of heavy ions, 3:27057 (BNL-23394)
CHLOROPHYLL
Annual progress report, September 1, 1976-November 30, 1977 (Chromophores in photosynthetic membranes and reaction centers of Rhodopseudomonas sp.), 3:26945 (COO-3162-36)
CHROMIUM/EMISSION SPECTROSCOPY
Determination of trace elements in soft, hard, and saline waters by the inductively coupled plasma, multi-element atomic emission spectroscopic (ICP-MAES) technique, 3:26664
CHROMIUM/ION EXCHANGE
Cation exchange of 53 elements in nitric acid, 3:26665 (LA-7083)
CHROMIUM/PHOTOEMISSION
X-ray photoemission spectra of the valence bands of the 3d transition metals, Sc to Fe, 3:26608
CHROMIUM 57/BETA-MINUS DECAY
New isotopes of interest to explosive nucleosynthesis (Half-lives, branching ratios, J, π), 3:27355 (ANL-77-60)
CHROMIUM BASE ALLOYS/WELDING
Development and evaluation of high chromium weld deposited overlays to protect less alloyed substrates from corrosion in a coal gasification atmosphere. Technical status report, December 1-December 31, 1977, 3:25643 (TID-28187)
CHROMIUM OXIDES/EMISSIVITY
Black chrome on commercially electroplated tin as a solar selective coating, 3:26061 (ERDA/NASA/1060-77/1)
CHROMIUM OXIDES/REFLECTIVITY
Black chrome on commercially electroplated tin as a solar selective coating, 3:26061 (ERDA/NASA/1060-77/1)
CHROMOSOMES/BIOLOGICAL RADIATION EFFECTS
Radiation effects on cells and chromosomes (A bibliography with abstracts). Report for 1964-August 1977, 3:26988 (NTIS/PS-77/0753)
CISTRONS
See GENES

CLAYS/COMPRESSIBILITY
Percolation through clay crusts, 3:25762
CLAYS/PERMEABILITY
Percolation through clay crusts, 3:25762
CLAYS/POROSITY
Percolation through clay crusts, 3:25762
CLIMATES
Energy and the climate, 3:26868 (ORAU/IEA(M)-75-3)
CLINCH RIVER BREEDER REACTOR/CONTROL ELEMENTS
Analysis of the thermal-hydraulic behavior in the CRBR secondary control assembly, including interassembly heat transfer effects, 3:26405 (COO-2245-47TR)
CLINCH RIVER BREEDER REACTOR/SEALS
Sodium technology and cover gas seal development programs. Quarterly technical progress report, July-September 1977, 3:26274 (AI-DOE-13208)
CLOSURES/FASTENERS
Screwing and holding device for lock nuts, especially for screwed joints of reactor pressure vessels (Patent), 3:26369
CLUSTER EMISSION MODEL/MULTIPLE PRODUCTION
Parton-picture unitary impact-parameter model for multicluster production, 3:27229
CNEN
(Comitato Nazionale Energia Nucleare.)
CNEN/LMFBR TYPE REACTORS
CNEN program on advanced LMFBR fuels, 3:26299
COAL
See also ANTHRACITE
BITUMINOUS COAL
COAL GASIFICATION
COAL LIQUEFACTION
LIGNITE
SOLVENT-REFINED COAL
SUBBITUMINOUS COAL
COAL/AVAILABILITY
National coal utilization assessment: the price and availability of low sulfur coal in eastern markets (Through 1985), 3:25719 (ANL/AA-12)
COAL/CALORIFIC VALUE
Preparation of a coal conversion systems technical data book. Project 8979 quarterly report, May 1-July 31, 1977, 3:25633 (FE-2286-20)
COAL/CARBONIZATION
Effect of charge preheat on the physical quality of coke from three Western coals, 3:25617 (GFERC/RI-77/3)
COAL/CHARGES
Annual summary of cost and quality of electric utility plant fuels, 1976, 3:25722 (TID-28133)
National coal utilization assessment: the price and availability of low sulfur coal in eastern markets (Through 1985), 3:25719 (ANL/AA-12)
National coal utilization assessment: modeling long-term coal production with the Argonne coal market model, 3:25720 (ANL/AA-13)
COAL/CHEMICAL ANALYSIS
Evaluation of the effects of coal cleaning on fugitive elements. January 1, 1977-August 31, 1977, 3:25707 (COO/4427-1)
Moessbauer spectroscopy of iron compounds found in West Virginia coals, 3:25671
Prospects for carbon-13 nuclear magnetic resonance analysis of solid fossil-fuel materials, 3:25668
COAL/CHEMICAL COMPOSITION
Evaluation of the effects of coal cleaning on fugitive elements. January 1, 1977-August 31, 1977, 3:25707 (COO/4427-1)
New method for sulphur concentration measurements in coal and char, 3:25670
COAL/CHEMICAL PROPERTIES
Effect of cleavage of ether linkages on physicochemical properties of coals, 3:25672
COAL/CHEMICAL REACTION KINETICS
Assessment of technology for the liquefaction of coal: summary, 3:25661 (FE/1216-2)
COAL/CHEMICAL REACTIONS
Homogeneous catalytic hydrocracking processes for conversion of coal to liquid fuels: basic and exploratory research. Quarterly report No. 7, May 1, 1977-July 31, 1977, 3:25653 (FE-2202-21)
COAL/CHEMISTRY
Search for a new coal technology, 3:25622 (CONF-770814-12)
COAL/CLEANING
Evaluation of the effects of coal cleaning on fugitive elements. January 1, 1977-August 31, 1977, 3:25707 (COO/4427-1)
COAL/COKING
Coking tests for Japanese coal blends by preheated-charging method, 3:25618
COAL/COMBUSTION
CFCC Development Program. Monthly report, November 1977, 3:26142 (FE-2357-19)
Coal-oil slurry combustion demonstration, Phase I. Monthly report, November 1977, 3:25714 (FE-2564-9)
Coal-oil slurry combustion demonstration, Phase I. Monthly report, December 1977, 3:25715 (FE-2564-10)
COAL/COMBUSTION PROPERTIES
Mathematical modelling of coal combustion in fluidized beds with sulphur emission control by limestone or dolomite, 3:25717
COAL/CONSUMPTION RATES
Annual summary of cost and quality of electric utility plant fuels, 1976, 3:25722 (TID-28133)
COAL/DENITRATION
Clean solid and liquid fuels from coal. Quarterly progress report, July-September 1977, 3:25665 (TID-28167)
COAL/DESULFURIZATION
Clean solid and liquid fuels from coal. Quarterly progress report, July-September 1977, 3:25665 (TID-28167)
COAL/ELECTRIC CONDUCTIVITY
Electrical conductivity of coal and coal char, 3:25674
COAL/FLUIDIZED-BED COMBUSTION
Centrifugal fluidized combustion of coal. Annual report for period ending September 1977, 3:25713 (FE-2516-4)
COAL/FLUIDIZED-BED COMBUSTORS
Mathematical modelling of coal combustion in fluidized beds with sulphur emission control by limestone or dolomite, 3:25717
COAL/HYDROGENATION
Hydrogen consumption in non-catalyzed coal liquefaction, 3:25664 (SAND-77-1560C)
Improved techniques for gasifying coal. Fourth quarterly report, April 1-June 30, 1977, 3:25635 (FE-2340-4)
Research and development of rapid hydrogenation for coal conversion to synthetic motor fuels (riser cracking of coal). Second quarter report, July 1-September 30, 1977, 3:25656 (FE-2307-25)
COAL/IN-SITU PROCESSING
Electrical induction heating: a new concept in in situ recovery, 3:25616
COAL/MARKET
National coal utilization assessment: modeling long-term coal production with the Argonne coal market model, 3:25720 (ANL/AA-13)
COAL/MATERIALS HANDLING
Possibilities of improving the reliability of systems for automatic loading of coal bunkers, 3:25708
COAL/PHYSICAL PROPERTIES
Effect of cleavage of ether linkages on physicochemical properties of coals, 3:25672
COAL/PRODUCTION
Coal and methane gas in the southeastern part of the Piceance Creek basin, Colorado, 3:25688
Geology of the Coal Basin area, Pitkin County, Colorado, 3:25687
COAL/PYROLYSIS
Electrical conductivity of coal and coal char, 3:25674
Hydrogen consumption in non-catalyzed coal liquefaction, 3:25664 (SAND-77-1560C)
Preparation of a coal conversion systems technical data book. Project 8979 monthly status report, November 1-November 30, 1977, 3:25615 (FE-2286-25)
Research and development of rapid hydrogenation for coal conversion to synthetic motor fuels (riser cracking of coal). Second quarter report, July 1-September 30, 1977, 3:25656 (FE-2307-25)
Search for a new coal technology, 3:25622 (CONF-770814-12)
COAL/RESOURCE ASSESSMENT
Energy systems and statistics, 3:26505 (LA-6807-PR)
COAL/SOLVENT EXTRACTION
Assessment of technology for the liquefaction of coal: summary, 3:25661 (FE/1216-2)
COAL/SORPTIVE PROPERTIES
Methane emissions from gassy coals in storage silos, 3:25706 (BM-RI-8269)
COAL/STORAGE
Methane emissions from gassy coals in storage silos, 3:25706 (BM-RI-8269)
Possibilities of improving the reliability of systems for automatic loading of coal bunkers, 3:25708
COAL/TRANSPORT
National coal utilization assessment: the price and availability of low sulfur coal in eastern markets (Through 1985), 3:25719 (ANL/AA-12)
National coal utilization assessment: modeling long-term coal production with the Argonne coal market model, 3:25720 (ANL/AA-13)
COAL DEPOSITS/DEGASSING
Effects of hydraulic stimulation on coalbeds and associated strata, 3:25689 (BM-RI-8260)
COAL DEPOSITS/EXPLOSIVE FRACTURING
Permeability from single and multiple detonations in boreholes, 3:25702
COAL DEPOSITS/GEOLOGY
Geology of the Coal Basin area, Pitkin County, Colorado, 3:25687

COAL DEPOSITS/HYDRAULIC FRACTURING
Effects of hydraulic stimulation on coalbeds and associated strata, 3:25689 (BM-RI-8260)
Underground investigation of the hydraulic fracture zone along the iota$_7$ seam at the Lisichansk Podzemgaz Station, 3:25705 (UCRL-Trans-11318)
COAL FINES/EXPLOSIONS
Aftergases of coal dust explosions generated in an experimental chamber, 3:25676
COAL FINES/RECYCLING
Modification and operation of the atmospheric ash-agglomerating gasifier on coal. Project 9020 monthly progress report, October 1977, 3:25634 (FE-2336-17)
COAL FUEL CELLS/RESEARCH PROGRAMS
Advanced technology fuel cell program. Interim report, 3:26543 (EPRI-EM-576)
COAL GAS/DESULFURIZATION
Advanced technology fuel cell program. Interim report, 3:26543 (EPRI-EM-576)
COAL GASIFICATION
See also AGGLOMERATING ASH PROCESS
BI-GAS PROCESS
CARBON DIOXIDE ACCEPTOR PROCESS
COALCON PROCESS
COGAS PROCESS
HYGAS PROCESS
IN-SITU GASIFICATION
LURGI PROCESS
SYNTHANE PROCESS
U-GAS PROCESS
COAL GASIFICATION/AIR POLLUTION ABATEMENT
Advanced fossil fuel and the environment: an executive report, 3:26192 (EPA-600/9-77-013)
COAL GASIFICATION/DEMONSTRATION PLANTS
Fossil energy demonstration plants, 3:25642 (TID-28182)
Low-Btu gas as an industrial energy source, 3:25625 (CONF-7710116-1)
COAL GASIFICATION/ECONOMICS
Coal chemistry or/instead of coal combustion, 3:25645
COAL GASIFICATION/EFFICIENCY
Analysis of coal hydrogasification processes. Monthly technical progress report, 1 December-31 December 1977, 3:25639 (FE-2565-10)
COAL GASIFICATION/LIQUID WASTES
Bio-oxidation of aqueous cyanogens typical of Synthane gasifier by-product water. Progress report, September 1, 1977-November 30, 1977, 3:26947 (COO/4502-1)
COAL GASIFICATION/MANUALS
Preparation of a coal conversion systems technical data book. Project 8979 monthly status report, November 1-November 30, 1977, 3:25615 (FE-2286-25)
Preparation of a coal conversion systems technical data book. Project 8979 quarterly report, May 1-July 31, 1977, 3:25633 (FE-2286-20)
COAL GASIFICATION/PILOT PLANTS
Quarterly technical progress report, October-December 1977, 3:25631 (FE-2240-79)
COAL GASIFICATION/PROCESS DEVELOPMENT UNITS
Advanced coal gasification system for electric power generation. Sixty-third monthly progress report, October 1977, 3:25628 (FE-1514-73)
COAL GASIFICATION/REVIEWS
Art of coal gasificaion, 3:25646
Future use of coal in energy generation, 3:25723
COAL GASIFICATION PLANTS/CAPITAL
ESCOE engineering program. Quarterly report, September 1-November 30, 1977, 3:25638 (FE-2468-18)
COAL GASIFICATION PLANTS/CORROSION
Thermodynamic phase stability diagrams for the analysis of corrosion reactions in coal gasification/combustion atmospheres. Interim report, 3:25626 (EPRI-FP-539)
COAL GASIFICATION PLANTS/COST
Coal gasification study handbook. Final report, 3:25620 (AD-A-042385)
COAL GASIFICATION PLANTS/MATERIALS
Development and evaluation of high chromium weld deposited overlays to protect less alloyed substrates from corrosion in a coal gasification atmosphere. Technical status report, December 1-December 31, 1977, 3:25643 (TID-28187)
COAL GASIFICATION PLANTS/PRESSURE VESSELS
Improvement of the mechanical reliability of monolithic refractory linings for coal gasification process vessels. Bimonthly letter progress report, October-November 1977, 3:25630 (FE-2218-15)
COAL GASIFICATION PLANTS/WATER REQUIREMENTS
Nationwide assessment of water quantity impacts of the National Energy Plan. Volume I. Summary and conclusions, 3:26932 (ORNL/TM-6098)
COAL INDUSTRY/ECONOMIC IMPACT
Management of social and economic impacts associated with the construction of large-scale projects: experiences from the Western coal development communities, 3:26496 (BNWL-RAP-16)
COAL INDUSTRY/FORECASTING
Medium-term aspects of a coal revival: two case studies, 3:25721 (IIASA-CP-77-5)
COAL INDUSTRY/SOCIAL IMPACT
Management of social and economic impacts associated with the construction of large-scale projects: experiences from the Western coal development communities, 3:26496 (BNWL-RAP-16)
COAL LIQUEFACTION
See also COSTEAM PROCESS
H-COAL PROCESS
SRC-II PROCESS
SYNTHOIL PROCESS
First Federal attempt to demonstrate a synthetic fossil energy technology: a failure, 3:26519 (EMD-77-59)
Hydrogen consumption in non-catalyzed coal liquefaction, 3:25664 (SAND-77-1560C)
COAL LIQUEFACTION/AIR POLLUTION ABATEMENT
Advanced fossil fuel and the environment: an executive report, 3:26192 (EPA-600/9-77-013)
COAL LIQUEFACTION/CATALYSTS
Catalyst development for coal liquefaction. Annual report, July 1, 1976-June 30, 1977, 3:25657 (FE-2335-13)
Catalyst development for coal liquefaction. Interim report, July-September 1977, 3:25658 (FE-2335-16)
Effects of mineral matter on the hydroliquefaction of coal, 3:25663 (SAND-77-1558C)
Homogeneous catalytic hydrocracking processes for conversion of coal to liquid fuels: basic and exploratory research. Quarterly report No. 7, May 1, 1977-July 31, 1977, 3:25653 (FE-2202-21)
COAL LIQUEFACTION/CHEMICAL REACTION KINETICS
Homogeneous catalytic hydrocracking processes for conversion of coal to liquid fuels: basic and exploratory research. Quarterly report No. 7, May 1, 1977-July 31, 1977, 3:25653 (FE-2202-21)
COAL LIQUEFACTION/DEMONSTRATION PLANTS
Fossil energy demonstration plants, 3:25642 (TID-28182)
COAL LIQUEFACTION/ECONOMICS
Assessment of technology for the liquefaction of coal: summary, 3:25661 (FE/1216-2)
Coal chemistry or/instead of coal combustion, 3:25645
COAL LIQUEFACTION/MANUALS
Preparation of a coal conversion systems technical data book. Project 8979 monthly status report, November 1-November 30, 1977, 3:25615 (FE-2286-25)
Preparation of a coal conversion systems technical data book. Project 8979 quarterly report, May 1-July 31, 1977, 3:25633 (FE-2286-20)
COAL LIQUEFACTION/PILOT PLANTS
Coal liquefaction pilot plant, Cresap, West Virginia. Monthly technical progress report, September 1977, 3:25649 (FE-1517-55)
Coal liquefaction pilot plant, Cresap, West Virginia. Monthly technical progress report, November 1977, 3:25650 (FE-1517-58)
COAL LIQUEFACTION/RECOMMENDATIONS
Assessment of technology for the liquefaction of coal: summary, 3:25661 (FE/1216-2)
COAL LIQUEFACTION/REVIEWS
Assessment of technology for the liquefaction of coal: summary, 3:25661 (FE/1216-2)
COAL LIQUEFACTION PLANTS/CAPITAL
ESCOE engineering program. Quarterly report, September 1-November 30, 1977, 3:25638 (FE-2468-18)
COAL LIQUEFACTION PLANTS/PUMPS
Evaluation of materials for use in letdown valves and coal feed pumps for coal liquefaction service. Final report, 3:25647 (EPRI-AF-579)
COAL LIQUEFACTION PLANTS/VALVES
Evaluation of materials for use in letdown valves and coal feed pumps for coal liquefaction service. Final report, 3:25647 (EPRI-AF-579)
COAL LIQUEFACTION PLANTS/WATER REQUIREMENTS
Nationwide assessment of water quantity impacts of the National Energy Plan. Volume I. Summary and conclusions, 3:26932 (ORNL/TM-6098)
COAL LIQUIDS/COMBUSTION
EDS coal liquefaction process development, Phase III B. Monthly technical progress report, December 1-December 31, 1977, 3:25660 (FE-2893-6)
Ignition of droplets of liquid fuels solvent extracted from coal, 3:25718

COAL LIQUIDS/ENTHALPY
Enthalpy measurement of coal-derived liquids. Quarterly technical progress report, October-December 1977 (SRC-1 naphtha: 160 to 670°F and 30 to 900 psia), 3:25652 (FE-2035-10)
Preparation of a coal conversion systems technical data book. Project 8979 quarterly report, May 1-July 31, 1977, 3:25633 (FE-2286-20)
COAL LIQUIDS/FRACTIONATION
Clean solid and liquid fuels from coal. Quarterly progress report, July-September 1977, 3:25665 (TID-28167)
COAL LIQUIDS/GAS CHROMATOGRAPHY
Clean solid and liquid fuels from coal. Quarterly progress report, July-September 1977, 3:25665 (TID-28167)
Spectral studies of coal-derived liquids, 3:25667 (PERC/RI-77/14)
COAL LIQUIDS/HYDROGENATION
Clean solid and liquid fuels from coal. Quarterly progress report, July-September 1977, 3:25665 (TID-28167)
COAL LIQUIDS/INFRARED SPECTRA
Spectral studies of coal-derived liquids, 3:25667 (PERC/RI-77/14)
COAL LIQUIDS/MASS SPECTROSCOPY
Clean solid and liquid fuels from coal. Quarterly progress report, July-September 1977, 3:25665 (TID-28167)
Spectral studies of coal-derived liquids, 3:25667 (PERC/RI-77/14)
COAL LIQUIDS/NUCLEAR MAGNETIC RESONANCE
Spectral studies of coal-derived liquids, 3:25667 (PERC/RI-77/14)
COAL LIQUIDS/RAMAN SPECTRA
Spectral studies of coal-derived liquids, 3:25667 (PERC/RI-77/14)
COAL LIQUIDS/REFINING
Assessment of technology for the liquefaction of coal: summary, 3:25661 (FE/1216-2)
COAL LIQUIDS/VISCOSITY
Effects of mineral matter on the hydroliquefaction of coal, 3:25663 (SAND-77-1558C)
COAL LIQUIDS/YIELDS
EDS coal liquefaction process development, Phase III B. Monthly technical progress report, December 1-December 31, 1977, 3:25660 (FE-2893-6)
COAL MINES/BIBLIOGRAPHIES
Acid mine drainage (a bibliography with abstracts). Report for 1964-Nov 77, 3:26931 (NTIS/PS-77/0949)
COAL MINES/COMMUNICATIONS
Underground mine communications. IV. Section-to-place communications. Information circular, 3:25693 (PB-270189)
COAL MINES/DEGASSING
Investigation of effects of concussion blasting combined with drilling destressing boreholes in roadsides, on the reduction of gas and rock bursts hazards, 3:25699
COAL MINES/FIRE HAZARDS
Precautionary measures to reduce the probability of incipient heatings in coal mines, their early detection and safety procedures in dealing with colliery fires, 3:25724
COAL MINES/FIRE PREVENTION
Precautionary measures to reduce the probability of incipient heatings in coal mines, their early detection and safety procedures in dealing with colliery fires, 3:25724
COAL MINES/LAND RECLAMATION
Coal surface mining reclamation costs in the western United States. Information circular, 3:25686 (PB-269945)
COAL MINES/LIGHTING SYSTEMS
Methods of protection of obviate hazardous sparkaing in explosion-proof luminaries with fluorescent lamps, 3:25725
COAL MINES/MEASURING INSTRUMENTS
General considerations of the design of instruments for use in coal mines, 3:25703
COAL MINES/ROCK BURSTS
Criterion for gas, coal and rock bursts, 3:25697
Investigation of effects of concussion blasting combined with drilling destressing boreholes in roadsides, on the reduction of gas and rock bursts hazards, 3:25699
COAL MINES/VENTILATION
Methane accumulations in coal mine roof cavities, 3:25691 (BM-RI-8267)
Precautionary measures to reduce the probability of incipient heatings in coal mines, their early detection and safety procedures in dealing with colliery fires, 3:25724
COAL MINING
See also ACID MINE DRAINAGE
LONGWALL MINING
SURFACE MINING
UNDERGROUND MINING
COAL MINING/COST
Limits and cost sensitivity of alternate parting handling methods. Volume I. Final summary report, December 1975-March 1977, 3:25692 (PB-270024)
COAL MINING/MINING EQUIPMENT
Linear cutting rotary head continuous mining machine (Patent), 3:25701
Method of operating a constant depth linear cutting head on a retrofitted continuous mining machine (Patent), 3:25700
National coal utilization assessment: the price and availability of low sulfur coal in eastern markets (Through 1985), 3:25719 (ANL/AA-12)
COAL MINING/PRODUCTIVITY
Interactions among the National Energy Plan and the President's Environmental Message: the Coal Conversion Regulatory Program, 3:26516 (TID-28130)
National coal utilization assessment: the price and availability of low sulfur coal in eastern markets (Through 1985), 3:25719 (ANL/AA-12)
National coal utilization assessment: modeling long-term coal production with the Argonne coal market model, 3:25720 (ANL/AA-13)
COAL PREPARATION
Analysis of pulverized fuel preparation systems equipped with different mills, for an 800 mw block fired by Kansk-Achinsk coal varieties, 3:25709
Evaluation of the effects of coal cleaning on fugitive elements. January 1, 1977-August 31, 1977, 3:25707 (COO/4427-1)
COAL TAR/YIELDS
Flash pyrolysis coal liquefaction process development. Monthly report, July 1977, 3:25654 (FE-2244-15)
COALCON PROCESS/DEMONSTRATION PLANTS
First Federal attempt to demonstrate a synthetic fossil energy technology: a failure, 3:26519 (EMD-77-59)
COAL-DERIVED LIQUIDS
See COAL LIQUIDS
COAL-FIRED MHD GENERATORS/AIR HEATERS
Testing and evaluation of MHD materials and substructures. Quarterly technical progress report, January-March 1977, 3:26538 (FE-2246-3(Rev.A))
COAL-FIRED MHD GENERATORS/BOILERS
Testing and evaluation of MHD materials and substructures. Quarterly technical progress report, January-March 1977, 3:26538 (FE-2246-3(Rev.A))
COAL-FIRED MHD GENERATORS/FUEL SYSTEMS
Testing and evaluation of MHD materials and substructures. Quarterly technical progress report, January-March 1977, 3:26538 (FE-2246-3(Rev.A))
COAL-FIRED MHD GENERATORS/SEED RECOVERY
Testing and evaluation of MHD materials and substructures. Quarterly technical progress report, January-March 1977, 3:26538 (FE-2246-3(Rev.A))
COASTAL REGIONS/OIL SPILLS
Contingency planning for the impact of oil spills in different coastal environments of Canada. Technical report, 3:26905 (AD-A-043713)
COASTAL WATERS/TEMPERATURE MONITORING
Oceanography, 3:27021 (TID-26712)
COATED FUEL PARTICLES
Pyrocarbon-coated fuel particles for fuel elements of HTR reactors (Patent), 3:26264
COATED FUEL PARTICLES/FABRICATION
Method and device for coating of particles, containing fissile, fertile or absorber material, used for HTR fuel elements (Patent), 3:26270
Method for the fabrication of a fuel body from an agglomerate of fuel particles (Patent), 3:26397
Method for the coating of particles with single layers of pyrolytic carbon having different densities (Patent), 3:26269
COATED FUEL PARTICLES/FISSION PRODUCT RELEASE
COPAR, a program to compute release of metallic fission products from coated particles (HTGR), 3:26254 (GA-A-14034)
COATINGS
See also ANTIREFLECTION COATINGS
DIPPED COATINGS
COATINGS/COST
Comparison of solar photothermal coatings, 3:26071
COATINGS/OPTIMIZATION
Optimization of coatings for flat plate solar collectors, Phase II. Final report, 28 June 1976-27 June 1977, 3:26060 (COO-2930-12)
COATINGS/REVIEWS
Comparison of solar photothermal coatings, 3:26071
COATINGS/TESTING
Testing tar-epoxide-coating materials under practice-like conditions in the laboratory, 3:26703
COBALT/CATALYTIC EFFECTS
Effects of mineral matter on the hydroliquefaction of coal, 3:25663 (SAND-77-1558C)
COBALT/EMISSION SPECTROSCOPY
Determination of trace elements in soft, hard, and saline waters by the inductively coupled plasma, multi-element atomic emission spectroscopic (ICP-MAES) technique, 3:26664
COBALT/HYPERFINE STRUCTURE
Self-consistent screening of a positive muon in a spin-polarized electron gas, 3:26604
COBALT/INTERSTITIALS
Self-consistent screening of a positive muon in a spin-polarized electron gas, 3:26604

COBALT/ION EXCHANGE
Cation exchange of 53 elements in nitric acid, 3:26665 (LA-7083)
COBALT/NEUTRON DIFFRACTION
Small-angle critical neutron scattering from cobalt, 3:26612
COBALT/SPIN WAVES
Small-angle critical neutron scattering from cobalt, 3:26612
COBALT 56/ENERGY LEVELS
$^{56}Fe(^{3}He,t)^{56}Co$ reaction, 3:27349
COBALT 59 TARGET/LITHIUM 7 REACTIONS
High-spin states in ^{64}Zn, 3:27357
COBALT 59 TARGET/NEUTRON REACTIONS
Cross sections for (n,2n) and (n,3n) reactions above 14 MeV, 3:27353
Equilibrium, pre-equilibrium, and direct processes in the (n,n') reaction, 3:27354
COBALT 60/ENVIRONMENTAL TRANSPORT
Ecology of Hanford 200 Area and 1976 radionuclide inventory, 3:25944 (PNL-2253)
COGAS PROCESS/DEMONSTRATION PLANTS
Fossil energy demonstration plants, 3:25642 (TID-28182)
COKE/MECHANICAL PROPERTIES
Effect of charge preheat on the physical quality of coke from three Western coals, 3:25617 (GFERC/RI-77/3)
COKE/PRODUCTION
Coking tests for Japanese coal blends by preheated-charging method, 3:25618
COKE OVENS/POLLUTION CONTROL EQUIPMENT
Emission testing and evaluation of Ford/Koppers coke pushing control system. Volume I. Final report. Report for Dec 73-Aug 77, 3:25684 (PB-273812)
COKE-OVEN GAS
See COAL GAS
COLD LAKE DEPOSIT/IN-SITU PROCESSING
Oil sands in situ projects continue at impressive rate, 3:25897
COLD PLASMA/ELECTROMAGNETIC RADIATION
Induced radiation from a plasma cylinder, 3:27577
COLEOPTILE/CELL WALL
Studies on the control of cell wall extension. Progress report, July 1, 1976-September 1, 1977, 3:26949 (RLO/2225/T19-43)
COLLECTIVE MODEL/HAMILTONIAN FUNCTION
Microscopic theory of nuclear quadrupole excitations, 3:27389
COLLIDING BEAMS/BEAM LUMINOSITY
Comparison of anti p anti p and pp luminosities at Fermilab, 3:27215 (ANL-HEP-CP-77-81)
COLLIERIES
See COAL MINES
COLLISIONAL PLASMA/COLLISIONAL HEATING
To the theory of heating of collisional plasma by means of magnetic pumping by axial-asymmetric variable fields, 3:27465
COLLISIONAL PLASMA/KINK INSTABILITY
Moment equations treatment of the reconnecting mode, 3:27553
COLLISIONAL PLASMA/MAGNETIC-PUMPING HEATING
To the theory of heating of collisional plasma by means of magnetic pumping by axial-asymmetric variable fields, 3:27465
COLLISIONAL PLASMA/TRANSPORT THEORY
Moment equation approach to neoclassical transport theory, 3:27511
COLLISIONAL PLASMA/TRAPPED-PARTICLE INSTABILITY
Observation of the dissipative trapped electron instability in toroidal geometry, 3:27543
COLLISIONLESS PLASMA/PLASMA WAVES
Non-linear Langmuir wave modulation in collisionless plasma, 3:27575
COLOR MODEL/LIE GROUPS
Constraint on color gauge groups, 3:27263
COLORADO/COAL DEPOSITS
Geology of the Coal Basin area, Pitkin County, Colorado, 3:25687
COLORADO/ENERGY SOURCE DEVELOPMENT
Western States energy resource development update 1976, 3:26503
COLORADO/GEOTHERMAL RESOURCES
Use of geothermometer models in the exploration for a hydrogeothermal resource, 3:26097
COLORADO/NATURAL GAS DEPOSITS
Fractured shale hydrocarbon reservoirs in southern Rocky Mountain basins, 3:25734
Geology and petroleum of the Mancos B formation, Douglas Creek arch area, Colorado and Utah, 3:25738
Geology and gas exploration potential, Upper Cretaceous and Lower Tertiary strata, northern Raton basin, Colorado, 3:25828
Oil potential of Mesozoic sediments beneath the Independence Mountain thrust fault, North Park, Colorado, 3:25731
Petroleum potential of southwestern Wyoming and adjacent areas, 3:25737
Shallow marine deposits in the Upper Cretaceous Pierre Shale of the northern Denver basin and their relation to hydrocarbon accumulation, 3:25739
Structural style in relation to oil and gas exploration in North Park-Middle Park basin, Colorado, 3:25730
COLORADO/NATURAL GAS FIELDS
Application of massive hydraulic fracturing to the tight Muddy "J" Formation, Wattenberg field, Colorado, 3:25861
Beecher Island field, Yuma County, Colorado, 3:25833
COLORADO/OIL SHALE DEPOSITS
Oil shale and the environment, 3:25902 (EPA-600/9-77-033)
COLORADO/PETROLEUM DEPOSITS
Biostratigraphic correlation of the Mesaverde Group in southwestern Wyoming and northwestern Colorado, 3:25736
Fractured shale hydrocarbon reservoirs in southern Rocky Mountain basins, 3:25734
Geology and petroleum of the Mancos B formation, Douglas Creek arch area, Colorado and Utah, 3:25738
Interpretation of seismic reflection data from the central South Park basin, Colorado, 3:25732
Oil potential of Mesozoic sediments beneath the Independence Mountain thrust fault, North Park, Colorado, 3:25731
Petroleum potential of southwestern Wyoming and adjacent areas, 3:25737
Preliminary report: petroleum geochemistry of the Denver basin, 3:25741
Seismic investigation of the Colorado Front Range Zone of flank deformation immediately north of Golden, Colorado, 3:25733
Shallow marine deposits in the Upper Cretaceous Pierre Shale of the northern Denver basin and their relation to hydrocarbon accumulation, 3:25739
Structural style in relation to oil and gas exploration in North Park-Middle Park basin, Colorado, 3:25730
COLORADO/URANIUM DEPOSITS
Geophysical techniques used in uranium exploration, 3:25909
COLUMBIUM
See NIOBIUM
COMBINED-CYCLE POWER PLANTS/BIBLIOGRAPHIES
Combined cycle power generation (citations from the NTIS data base). Report for 1964-Oct 77, 3:26147 (NTIS/PS-77/0991)
Combined cycle power generation (citations from the Engineering Index data base). Report for 1970-Oct 77, 3:26148 (NTIS/PS-77/0992)
COMBINED-CYCLE POWER PLANTS/CAPITAL
Combined cycle power plant, capital cost estimates. Final report, 3:26189 (EPRI-AF-610)
COMBINED-CYCLE POWER PLANTS/COST
Combined cycle power plant, capital cost estimates. Final report, 3:26189 (EPRI-AF-610)
COMBINED-CYCLE POWER PLANTS/DESIGN
CFCC Development Program. Monthly report, November 1977, 3:26142 (FE-2357-19)
Evaluation of a pressurized-fluidized bed combustion (PFBC) combined cycle power plant conceptual design. Quarterly report, July 1-September 30, 1977, 3:26143 (FE-2371-20)
COMBINED-CYCLE POWER PLANTS/GAS TURBINES
Development of high temperature turbine subsystem technology to a "technology readiness status": Phase I. Quarterly report, January-March 1977. Preliminary draft, 3:26141 (FE-1806-20)
COMBINED-CYCLE POWER PLANTS/MHD GENERATORS
Comparative evaluation of the technical and economic indices of MHD and thermionic add-on units for steam-turbine power plants, 3:26150 (JPRS-69811)
COMBINED-CYCLE POWER PLANTS/RESEARCH PROGRAMS
Combined cycle research program, January 1-March 31, 1977, 3:26145 (MIT-2295-T18-3)
Combined cycle research program. First annual report, July 1, 1976-June 30, 1977, 3:26146 (MIT-2295-T18-4)
COMBINED-CYCLE POWER PLANTS/THERMIONIC CONVERTERS
Comparative evaluation of the technical and economic indices of MHD and thermionic add-on units for steam-turbine power plants, 3:26150 (JPRS-69811)
COMBUSTION
See also FLUIDIZED-BED COMBUSTION
COMBUSTION/MONITORING
Review of laser raman and fluorescence techniques for practical combustion diagnostics. Final report on Task 1, October 1976-March 1977, 3:26701 (PB-269653)
COMBUSTION ENGINEERING STANDARD REACTOR
See CE STANDARD REACTOR
COMBUSTORS
See also BURNERS
COMBUSTORS/DESIGN
Development of high temperature turbine subsystem technology to a "technology readiness status": Phase I. Quarterly report, January-March 1977. Preliminary draft, 3:26141 (FE-1806-20)
COMMERCIAL BUILDINGS/LIGHTING SYSTEMS
Recommendations for enforcing and administering lighting-efficiency standards in existing public buildings in New York State. Final report, 3:26509 (HCP/M1223-1)

COMMERCIAL BUILDINGS/RETROFITTING
Energy conservation retrofit process for existing public and institutional facilities, 3:26510
COMMERCIAL NUCLEAR SHIPS
Future of nuclear propulsion in merchant ships, 3:26429
COMMON MARKET/ENERGY CONSUMPTION
International energy trends: 3rd quarter 1977 and recent trends, 3:26528 (NP-23033)
COMMUNICATIONS/BLAST EFFECTS
Characteristics of late-time striations observed during operation stress, 3:27044 (LA-UR-77-2835)
COMMUNITIES/DISTRICT HEATING
District heating as a task for government and economy. Existing networks to be extended systematically: special responsibilities for communities, 3:26508
COMMUNITIES/ENERGY SOURCE DEVELOPMENT
Management of social and economic impacts associated with the construction of large-scale projects: experiences from the Western coal development communities, 3:26496 (BNWL-RAP-16)
COMMUNITIES (ECOLOGICAL)
See ECOSYSTEMS
COMPOSITE MODELS
See also BOOTSTRAP MODEL
PARTON MODEL
Composite gauge fields and models, 3:27203
Relativistic composite systems and extensible models of fields and particles, 3:27166
COMPOUND PARABOLIC CONCENTRATORS
See also PARABOLIC REFLECTORS
COMPOUND PARABOLIC CONCENTRATORS/DESIGN
Analysis of design changes necessary to adapt receiver to compound parabolic reflector. Final report (Vacuum tube receivers), 3:26059 (ANL-K-3805-1)
COMPOUNDS (ORGANIC)
See ORGANIC COMPOUNDS
COMPRESSORS
See also GAS COMPRESSORS
COMPRESSORS/ACOUSTIC MONITORING
Measurement techniques for AGR circulators in a full-density rig, 3:26265
COMPRESSORS/MECHANICAL VIBRATIONS
Measurement techniques for AGR circulators in a full-density rig, 3:26265
COMPRESSORS/PERFORMANCE
Current-state of off-design calculation methods for multistage axial-flow compressors, 3:26568
COMPUTER CODES
See also TRANSLATORS
COMPUTER CODES/A CODES
Energy dependent air/ground correction factors for the ATR (air transport of radiation) code. Final report, 3:27400 (AD-A-043807)
COMPUTER CODES/AIR POLLUTION
PATRIC: a three dimensional particle-in-cell sequential puff code for modeling the transport and diffusion of atmospheric pollutants, 3:26884 (UCID-17701)
COMPUTER CODES/B CODES
BBCPLOT users manual (For 7600 and STAR computers), 3:27709 (UCID-17719)
COMPUTER CODES/C CODES
COPAR, a program to compute release of metallic fission products from coated particles (HTGR), 3:26254 (GA-A-14034)
User's instructions for preliminary version of the CONCEPT-5 computer code (For cost estimation of coal-fired and nuclear power plants, in FORTRAN for IBM 360/95), 3:26190 (ORNL/TM-6230)
COMPUTER CODES/DOCUMENTATION
Software documentation guidelines and procedures for Applicon systems, 3:27708 (SAND-77-1831)
COMPUTER CODES/E CODES
ETA-MACRO: a model of energy-economy interactions (Simulates market economy through dynamic nonlinear optimization process), 3:26497 (EPRI-EA-592)
COMPUTER CODES/F CODES
FLEX: a code for calculating neutron flux microdistributions in lattices consisting of hexagonal fuel assemblies, 3:26346
COMPUTER CODES/G CODES
GMAPS user's manual (For CDC 6600), 3:26917 (LA-6975-M)
COMPUTER CODES/K CODES
Calculation of two-phase flow and fracturing in a porous medium (abstract), 3:26085
COMPUTER CODES/L CODES
Energy and Resource Planning Group FY 1977 annual report (Use of LLL Energy Model (LLLEM)), 3:26495 (UCRL-50029-77)
COMPUTER CODES/P CODES
Coupling of x-ray deposition to structural response. Final report (RIP; PETROS 3), 3:27398 (AD-A-042667)
Evaluations of the piping system inelastic analysis computer program PIRAX2 (LMFBR), 3:26276 (AI-DOE-13216)
COMPUTER CODES/R CODES
Coupling of x-ray deposition to structural response. Final report (RIP; PETROS 3), 3:27398 (AD-A-042667)
COMPUTER CODES/S CODES
Description of the code SCALID for calculating the one dimensional SGEMP boundary layer. Topical report (In FORTRAN), 3:26833 (AD-A-043519)
Installation independent version of the Sandia SCORS plot system, 3:27706 (SAND-77-1179)
SIMPLE code (Solution of equations of inviscid compressible hydrodynamics and simple heat conduction), 3:26770 (UCID-17715)
STEAEC: Solar Thermal Electric Annual Energy Calculator documentation, 3:26033 (SAND-77-8278)
COMPUTER CODES/T CODES
TECAR, a new program for LOCA analysis (BWR; PWR), 3:26448
TRIDENT: a new triangular mesh discrete ordinates code, 3:27616 (LA-UR-77-2511)
COMPUTER CODES/U CODES
User/programmer guide for UCMD 47: thin film resistor layout (In FORTRAN or assembly language for PDP-11), 3:26775 (SAND-77-2035)
COMPUTER PROGRAMMING
See PROGRAMMING
COMPUTER-AIDED DESIGN/COMPUTER CODES
Software documentation guidelines and procedures for Applicon systems, 3:27708 (SAND-77-1831)
CONCENTRATING COLLECTORS/DESIGN
Analysis of design changes necessary to adapt receiver to compound parabolic reflector. Final report (Vacuum tube receivers), 3:26059 (ANL-K-3805-1)
Line focus segmented mirror concentrator, 3:26076
Principles of fixed mirror solar concentrator (With tracking heat receiver), 3:26077
Solar collectors using total internal reflections, 3:26078
CONCENTRATING COLLECTORS/PERFORMANCE
Line focus segmented mirror concentrator, 3:26076
Principles of fixed mirror solar concentrator (With tracking heat receiver), 3:26077
CONCENTRATING COLLECTORS/SHADING
Focused solar collector analysis with axially varying input due to shadowing from adjacent collectors, 3:26068
CONCRETES
See also REINFORCED CONCRETE
CONCRETES/FRACTURING
Performance of a high-pressure pulsed water-jet device for fracturing concrete pavement (For maintenance of underground utilities), 3:26704 (CONF-780409-1)
CONDENSATES/CHEMICAL PROPERTIES
Oil and gas condensate from Luginets field, 3:25795
CONDENSATES/PHYSICAL PROPERTIES
Oil and gas condensate from Luginets field, 3:25795
CONDENSATION CHAMBERS/DESIGN
Underground pressure suppression system for Boiling Water Reactors (BWRs), 3:26212 (UCID-17695)
CONDENSERS/EFFICIENCY
Studies of hydrogen liquefier efficiency and the recovery of the liquefaction energy, 3:25957 (PB-274058)
CONDENSERS/PERFORMANCE
Studies of hydrogen liquefier efficiency and the recovery of the liquefaction energy, 3:25957 (PB-274058)
CONNECTORS/FABRICATION
Manufacture of an interconnector (Patent), 3:26381
CONSERVATION (RESOURCE)
See RESOURCE CONSERVATION
CONTACTORS
See SWITCHES
CONTAINERS
See also PRESSURE VESSELS
TANKS
CONTAINERS/MATERIALS
Compatibility testing of vitrified waste forms, 3:25936 (DP-MS-77-115)
CONTAINMENT BUILDINGS
Reactor building for a nuclear reactor (Patent), 3:26479
CONTAINMENT BUILDINGS/COST
Containment for small pressurized water reactors, 3:26227 (CONF-771109-90)
CONTAINMENT BUILDINGS/LEAK TESTING
Process and device of leak testing of works, especially concrete works (Patent), 3:26386
CONTAINMENT BUILDINGS/SEALS
Process for the continuous control of the seal and strength of the containment of a reactor utilizing said process (Patent; LMFBR), 3:26289 (ANL-Trans-1111)

CONTAINMENT BUILDINGS/SPECIFICATIONS
Containment for small pressurized water reactors, 3:26227 (CONF-771109-90)
CONTAINMENT SHELLS/THERMAL STRESSES
Steady-state stresses in concrete structures subjected to sustained and cyclically varying temperatures, 3:26363
CONTAINMENT SYSTEMS/CONDENSATION CHAMBERS
Underground pressure suppression system for Boiling Water Reactors (BWRs), 3:26212 (UCID-17695)
CONTAINMENT SYSTEMS/TESTING
Preliminary scaled multivent test program plan, 3:26438 (NEDO-23697)
CONTINENTAL SHELF/NATURAL GAS FIELDS
Policies, practices, and responsibilities for safety and environmental protection in oil and gas operations on the Outer Continental Shelf, 3:25802 (NP-22640)
CONTINENTAL SHELF/OIL FIELDS
Policies, practices, and responsibilities for safety and environmental protection in oil and gas operations on the Outer Continental Shelf, 3:25802 (NP-22640)
CONTROL ELEMENTS/DISPLACEMENT GAGES
Device for measuring the position of control rods in nuclear reactors (Patent), 3:26410
CONTROL ROD DRIVES
Control rod drives for nuclear reactors (Patent), 3:26409
CONTROL ROD DRIVES/DAMPING
Device for damping the control rod drive of a nuclear reactor (Patent), 3:26411
CONTROL RODS
See CONTROL ELEMENTS
CONTROL THEORY (REACTOR)
See REACTOR KINETICS
CONVECTIVE INSTABILITIES
Instabilities in fluid layers and in reaction-diffusion systems: Steady states, time-periodic solutions, non-periodic attractors, and related convective and otherwise non-linear phenomena, 3:27542 (JEN-379)
COOLANT CLEANUP SYSTEMS
Plant engineering experience with primary water purification plants in nuclear power stations with pressurised and boiling water reactors, 3:26216
COOLANT CLEANUP SYSTEMS/DESIGN
Installation for purifying the liquid metal used for cooling the core of a fast neutron reactor (Patent), 3:26287 (ANL-Trans-1113)
COOLANTS
(See also specific coolant materials.)
Improvements in or relating to power plant coolant (Patent, N_2O_4), 3:26361
COOLERS
See HEAT EXCHANGERS
COOLING PONDS/FOG
Effect of the severe winter upon a cooling pond fog study, 3:26213
COOLING SYSTEM (REACTOR)
See REACTOR COOLING SYSTEMS
COOLING TOWERS
See also NATURAL DRAFT COOLING TOWERS
COOLING TOWERS/BIBLIOGRAPHIES
Cooling towers (citations from the NTIS data base). Report for 1964-August 1977, 3:26131 (NTIS/PS-77/0804)
Cooling towers: design and performance (citations from the Engineering Index Data Base). Report for 1970-August 1977, 3:26132 (NTIS/PS-77/0805)
Cooling towers: environmental studies (citations from the Engineering Index Data Base). Report for 1970-August 1977, 3:26133 (NTIS/PS-77/0806)
COOLING TOWERS/DESIGN
Cooling towers: design and performance (citations from the Engineering Index Data Base). Report for 1970-August 1977, 3:26132 (NTIS/PS-77/0805)
COOLING TOWERS/ENVIRONMENTAL EFFECTS
Cooling towers (citations from the NTIS data base). Report for 1964-August 1977, 3:26131 (NTIS/PS-77/0804)
Cooling towers: environmental studies (citations from the Engineering Index Data Base). Report for 1970-August 1977, 3:26133 (NTIS/PS-77/0806)
COOLING TOWERS/MATHEMATICAL MODELS
Application of statistical methods to obtain analytical characteristics of air condensing installations, 3:26138
COOLING TOWERS/PERFORMANCE
Cooling towers: design and performance (citations from the Engineering Index Data Base). Report for 1970-August 1977, 3:26132 (NTIS/PS-77/0805)
COOLING TOWERS/PERFORMANCE TESTING
CTI water cooling tower thermal performance: testing procedures and instrumentation, 3:26129 (CONF-770151-9)
COOLING TOWERS/PLUMES
Influence of method of cooling tower operation on plume length, 3:26137
COOLING TOWERS/STRESS ANALYSIS
Experimental investigations of buckling and stability determination of cooling tower shells, 3:26134
COPPER/AUGER EFFECT
Configuration-interaction effects on the L and M Auger spectra of Cu and Zn, 3:27049
COPPER/COLLISIONS
Production of orientation and alignment in heavy-ion-surface collisions, 3:27078
COPPER/ELECTRON-ATOM COLLISIONS
Measurement of the cross sections of copper atoms for excitation by electron impact, 3:27082
COPPER/EMISSION SPECTROSCOPY
Determination of trace elements in soft, hard, and saline waters by the inductively coupled plasma, multi-element atomic emission spectroscopic (ICP-MAES) technique, 3:26664
COPPER/ENVIRONMENTAL TRANSPORT
Corrections and revisions to the FORTRAN IV version of the Wisconsin Hydrologic Transport Model, 3:27003 (ORNL/NSF/EATC-29)
COPPER/HEAVY ION REACTIONS
Proton and pion spectra at large angles in relativistic heavy-ion collisions (800 MeV/N), 3:27332 (LBL-670)
COPPER/ION COLLISIONS
Production of orientation and alignment in heavy-ion-surface collisions, 3:27078
COPPER/ION EXCHANGE
Cation exchange of 53 elements in nitric acid, 3:26665 (LA-7083)
COPPER/PHYSICAL RADIATION EFFECTS
Radiation-annealing effects in energetic displacement cascades, 3:26628
COPPER 63 TARGET/NEUTRON REACTIONS
Coherent dissociation of neutrons on nuclei at 100-300 GeV/c, 3:27123
Inclusive charged-particle production in neutron-nucleus collisions, 3:27121
COPPER 63 TARGET/PHOTONUCLEAR REACTIONS
Pre-equilibrium particle decay in the photonuclear reactions, 3:27327
COPPER 63 TARGET/PROTON REACTIONS
Inclusive production of Λ^0 hyperons by 300-GeV protons: A dependence, 3:27129
COPPER 65 TARGET/LITHIUM 7 REACTIONS
High-spin states in ^{70}Ge, 3:27358
COPPER CHLORIDES/MAGNETIZATION
Neutron-diffraction study of the staggered magnetization of $CuCl_2 \times 2D_2O$, 3:26652
COPPER CHLORIDES/NEUTRON DIFFRACTION
Neutron-diffraction study of the staggered magnetization of $CuCl_2 \times 2D_2O$, 3:26652
COPPER IONS/ION-ATOM COLLISIONS
Radiative lifetimes of the low-lying levels of Na-like copper, 3:27080
CORONA (SOLAR)
See SOLAR CORONA
CORROSION PRODUCTS/REMOVAL
Method for removing radioactive corrosion products from the inner surfaces of a nuclear reactor (Patent), 3:26378
COSMIC GASES/ELECTRIC CURRENTS
Electric currents in cosmic plasmas, 3:27029 (TRITA-EPP-77-14)
COSMIC PARTICLES
See COSMIC RADIATION
COSMIC PIONS/ENERGY SPECTRA
Effect of the rise of the inelastic interaction cross section on the form of the energy spectrum of cosmic-ray hadrons, 3:27134
COSMIC RADIATION/ENERGY SPECTRA
Effect of the rise of the inelastic interaction cross section on the form of the energy spectrum of cosmic-ray hadrons, 3:27134
COSMIC RADIATION/INELASTIC SCATTERING
Effect of the rise of the inelastic interaction cross section on the form of the energy spectrum of cosmic-ray hadrons, 3:27134
COSMIC X-RAY SOURCES/VARIATIONS
Fluctuations of quasars and other astronomical sources: final report on New Research Initiatives Program W-210 (Cosmological distance, luminosity), 3:27024 (LA-7092-MS)
COSMOLOGY/RESEARCH PROGRAMS
Progress report for a research program in theoretical high-energy physics, 3:27146 (COO-3130TA-340)
COSTEAM PROCESS/CATALYSTS
Clean solid and liquid fuels from coal. Quarterly progress report, July-September 1977, 3:25665 (TID-28167)
COUPLED REACTOR CORES/NEUTRON TRANSPORT
Determination of the 'transit' time between two cores by a noise analysis method, 3:26354
Neutron transit time measurements on a two-different-core system, 3:26355
COVERINGS/MECHANICAL PROPERTIES
Consideration of encapsulants for photovoltaic arrays in terrestrial applications, 3:25999

COWS/RADIONUCLIDE KINETICS
Solubility of plutonium and americium-241 from rumen contents of cattle grazing on plutonium-contaminated desert vegetation in in vitro bovine gastrointestinal fluids, November 1974-May 1975 (Uptake of transuranics by dairy cows from contaminated forage with emphasis on excretion in milk), 3:26914 (NVO-171)
CRATERING EXPLOSIONS/MATHEMATICAL MODELS
Dynamic crater ejecta model. Final report, 1 October 1975-30 September 1976, 3:26855 (AD-A-042546)
CRATERING EXPLOSIONS/SIMULATION
Theoretical body and surface wave magnitudes for twelve numerically simulated cratering explosions. Topical report, 3:26850 (AD-A-043387)
CRBR REACTOR
See CLINCH RIVER BREEDER REACTOR
CRITICALITY/ALARM SYSTEMS
Performance tests of the ORGDP radiation detection instruments (Compliance with Criticality Accident Alarm Systems), 3:26821 (Y/DD-215)
CRITICALITY/RESEARCH PROGRAMS
Fission reactor critical experiments and analysis, 3:26345 (LA-6807-PR)
CRITICALITY ACCIDENTS
See RADIATION ACCIDENTS
CRUDE OIL
See PETROLEUM
CRYOGENICS/RESEARCH PROGRAMS
Cryogenics program, 3:26709 (LA-6807-PR)
CRYSTALS/CHARGED-PARTICLE TRANSPORT
Coherent excitation of nuclei and atoms on passing through a crystal. Effect of slowing down, 3:27402
CULTURES (CELLS)
See CELL CULTURES
CURIUM 243/TISSUE DISTRIBUTION
Solubility of plutonium and americium-241 from rumen contents of cattle grazing on plutonium-contaminated desert vegetation in in vitro bovine gastrointestinal fluids, November 1974-May 1975 (Uptake of transuranics by dairy cows from contaminated forage with emphasis on excretion in milk), 3:26914 (NVO-171)
CURIUM 244/ENVIRONMENTAL TRANSPORT
Radionuclide transport (Hanford terrestrial ecosystems), 3:25948 (PNL-2253)
CYCLOHEXANE/EQUILIBRIUM
Preparation of a coal conversion systems technical data book. Project 8979 quarterly report, May 1-July 31, 1977 (NH_3-CO_2-H_2S-H_2O, cyclohexane-H_2O), 3:25633 (FE-2286-20)
CYCLOHEXANOL/SORPTIVE PROPERTIES
Absorption of ammonia with organic solvents, 3:25969
CYCLONE SEPARATORS/EFFICIENCY
Improved techniques for gasifying coal. Fourth quarterly report, April 1-June 30, 1977, 3:25635 (FE-2340-4)
CYCLOTRON INSTABILITY
Comparative study of the axial and azimuthal bunching mechanisms in electromagnetic cyclotron instabilities, 3:27546
CYCLOTRONS/ISOTOPE PRODUCTION
Biomedical research and application utilizing cyclotron produced radionuclides. Progress report, January 1 1977-December 31, 1977, 3:26971 (COO/4268-1)
CYTOLOGICAL TECHNIQUES
Gross distortions in freeze-dried tissue preparations, 3:26956 (CONF-770504-)
Procedural tip for intestine sections, 3:26958 (CONF-770504-)
Three-hour rapid processing technique for electron microscopy, 3:26957 (CONF-770504-)
CYTOLOGICAL TECHNIQUES/COMPARATIVE EVALUATIONS
Applications of interference microscopy for measurements on the cell nucleus in comparison with impulse cytophotometry, 3:26966 (LA-tr-78-4)

D

D RESONANCES/DECAY
Observation of D^0-meson decay into $K^- \pi^+ \pi^0$, 3:27113
Phenomenological model for charmed meson decay, 3:27221
Recent results on new particle production at SPEAR (Tau, π, mixing, mass, production cross sections), 3:27137 (SLAC-PUB-1998)
Search for $\pi^+ p \rightarrow D\text{-bar}^0 C_1^{++}$ near threshold, 3:27141
D RESONANCES/PARTICLE PRODUCTION
Search for $\pi^+ p \rightarrow D\text{-bar}^0 C_1^{++}$ near threshold, 3:27141
D RESONANCES/PARTICLE PROPERTIES
Recent results on new particle production at SPEAR (Tau, π, mixing, mass, production cross sections), 3:27137 (SLAC-PUB-1998)
D-1865 RESONANCES/DECAY
Search for $\pi^+ p \rightarrow D\text{-bar}^0 C_1^{++}$ near threshold, 3:27141
D-1865 RESONANCES/PARTICLE PRODUCTION
Search for $\pi^+ p \rightarrow D\text{-bar}^0 C_1^{++}$ near threshold, 3:27141
DAMS/FAILURES
Investigation of failure of Walter :Bouldin Dam FPC project No. 2146 and safety of other dams of the Alabama Company FPC project Nos. 82, 349, 618, 2146, 2165, 2203, 2407, 2408, 2628, 3:25975 (NP-23020)
DATA ACQUISITION SYSTEMS
New developments of the data acquisition system of TFR, 3:27695 (EUR-5602)
DATA ACQUISITION SYSTEMS/CAMAC SYSTEM
CC80-A microcomputer crate controller for CAMAC, 3:26842 (SLAC-PUB-1840)
DATA ACQUISITION SYSTEMS/SENSITIVITY
Application of a GC/MS data system at Rocky Flats (Analysis of organic compounds), 3:26839 (RFP-2558)
DATA PROCESSING
Using system 2000 with proposed ANSI standards for data exchange (Mechanism for conversion), 3:27717 (LA-UR-77-2739)
DC SYSTEMS/ENVIRONMENTAL IMPACTS
Alternative electrical transmission systems and their environmental impact, 3:26200 (PB-271652)
DECAHYDRONAPHTHALENE
See DECALIN
DECALIN/CATALYTIC CRACKING
Hydrocarbon cracking on amorphous and zeolithic cracking catalysts, 3:25764 (NP-22646)
DEFORMED NUCLEI/ROTATIONAL STATES
Microscopic theory of nuclear quadrupole excitations, 3:27389
DEHYDRATORS/PERFORMANCE TESTING
Efficiency of crude oil desalting in horizontal electrodehydrators, 3:25777
DELTA-1236 RESONANCES/PARTICLE PRODUCTION
Inclusive Δ^{++} (1232) production in 200-GeV/c π^- p interactions, 3:27132
DEMAND FACTORS/SIMULATION
Methodology for predicting the demand for new electricity-using goods. Final report, 3:26498 (EPRI-EA-593)
DENSITY/PHASE STUDIES
Density of liquid propylene on the curves of coexistence liquid--vapor, liquid--solid, 3:25818
DENSITY/THERMODYNAMIC PROPERTIES
Density of liquid propylene on the curves of coexistence liquid--vapor, liquid--solid, 3:25818
DEOXYPENTOSE NUCLEIC ACID
See DNA
DEOXYRIBONUCLEIC ACID
See DNA
DESOXYRIBONUCLEIC ACID
See DNA
DESULFURIZATION/TECHNOLOGY ASSESSMENT
Status of flue gas desulfurization applications in the United States: a technological assessment, 3:26194 (TID-28141)
Survey of the application of flue gas desulfurization technology in the industrial sector, 3:26786 (PB-270548)
DESULFURIZATION/TRANSPORT
Ekofisk-Emden gas pipeline, 3:25864
DETONATION WAVES
See SHOCK WAVES
DETONATORS/WAVE FORMS
Digital analysis of EBW burst wave forms. Final report, 3:26845 (BDX-613-1668(Rev.))
DEUTERIUM/ELECTRON-MOLECULE COLLISIONS
Rotational resonances in low-energy electron scattering by H_2 and D_2, 3:27071
DEUTERIUM/ENDOR
Electron-nuclear double resonance of V/sub OD/ defects in SrO, 3:26631
DEUTERIUM/ISOTOPE EFFECTS
Deuterated fluids: deuterated synthetic hydrocarbon fluid and grease. Final report, 3:26690 (AD-A-042618)
DEUTERIUM/ISOTOPIC EXCHANGE
Priori calculations on isotopic exchange equilibria, 3:26691
DEUTERIUM/RAMAN SPECTRA
Coherent anti-stokes Raman spectroscopy. Final report, 3:26669 (AD-A-042273)
DEUTERIUM OXIDES
See HEAVY WATER
DEUTERIUM TARGET/LEPTON REACTIONS
Relativistic interactions in nuclei and the approach to scaling in deep inelastic scattering, 3:27390 (SLAC-203)
DEUTERON BEAMS/PRODUCTION
Alternate approaches to D- beam production, 3:27659 (UCID-17672)

DEUTERON REACTIONS/PICKUP REACTIONS
Absolute cross sections for deuteron-induced reactions on ^{6}Li at energies below 1 MeV, 3:27337
DEUTERON REACTIONS/STRIPPING
Absolute cross sections for deuteron-induced reactions on ^{6}Li at energies below 1 MeV, 3:27337
DIAMINOCAPROIC ACID
See LYSINE
DIAMOND DRILLING EQUIPMENT
See DRILLING EQUIPMENT
DIAPHRAGMS (THERMONUCLEAR DEVICE)
See LIMITERS
DIES/MATERIALS
Study program to develop and evaluate die and container materials. First quarterly report, October 1977-December 1977 (For silicon solar cell fabrication), 3:25988 (DOE/JPL/954877-1)
DIESEL ENGINES/EXHAUST GASES
Experiments with novel fuels for diesel engines, 3:26591 (BERC/TPR-77/8)
DIESEL FUELS/COMBUSTION PRODUCTS
Experiments with novel fuels for diesel engines, 3:26591 (BERC/TPR-77/8)
DIESEL FUELS/DISTILLATION
Improvement of some properties of diesel fuel distillates, 3:25770
DIESEL FUELS/FIRE RESISTANCE
Corrective action program for bromochloromethane-containing fire-safe diesel fuel. Final report, 3:26590 (AD-A-043323)
DIESEL FUELS/PERFORMANCE TESTING
Corrective action program for bromochloromethane-containing fire-safe diesel fuel. Final report, 3:26590 (AD-A-043323)
DIESEL FUELS/PURIFICATION
Improvement of some properties of diesel fuel distillates, 3:25770
DIESEL FUELS/STABILITY
Review of diesel fuel deterioration and related problems. Interim report, 3:25812 (AD-A-043566)
DIESEL FUELS/STORAGE
Review of diesel fuel deterioration and related problems. Interim report, 3:25812 (AD-A-043566)
DIFFERENTIAL EQUATIONS
See also SCHROEDINGER EQUATION
DIFFERENTIAL EQUATIONS/ANALYTICAL SOLUTION
Some ad-hoc techniques for nonlinear partial differential equations (135 references), 3:27420
DIFFERENTIAL EQUATIONS/EIGENVALUES
Some recent results in bifurcation theory, 3:27421
DIFFERENTIAL EQUATIONS/INTEGRALS
Integral representations of particular integrals of a class of inhomogeneous linear ordinary differential equations, 3:27416
DIFFERENTIAL EQUATIONS/ITERATIVE METHODS
Incomplete cholesky - conjugate gradient method for the iterative solution of systems of linear equations, 3:27712
DIFFERENTIAL EQUATIONS/NUMERICAL SOLUTION
Collocation methods for integro-differential equations, 3:27713
DIGITAL FILTERS/DESIGN
Design of stable 2-D half-plane recursive filters using spectral factorization, 3:27711 (UCRL-80078)
DIGITIZERS/ELECTRONIC CIRCUITS
1K delay line digitizer (For External Muon Identifier experiment at Fermilab), 3:26830 (LBL-7215)
DIMETHYLKETONE
See ACETONE
DIOLS
See GLYCOLS
DIPPED COATINGS/OPTIMIZATION
Optimization of coatings for flat plate solar collectors, Phase II. Final report, 28 June 1976-27 June 1977, 3:26060 (COO-2930-12)
DIRAC MONOPOLES
See MAGNETIC MONOPOLES
DIRECT ENERGY CONVERTERS
See also EHD GENERATORS
MHD GENERATORS
SOLAR CELLS
THERMIONIC CONVERTERS
THERMOELECTRIC GENERATORS
DIRECT ENERGY CONVERTERS/EFFICIENCY
Experimental and computational results on direct energy conversion for mirror fusion reactors, 3:27666
DISASTERS
See ACCIDENTS
DISCHARGING (REACTOR)
See REACTOR FUELING
DISPLACEMENT GAGES
Device for measuring the position of control rods in nuclear reactors (Patent), 3:26410
DISTRICT HEATING
Obtaining thermal experimental multifactorial analytical characteristics of turbo-sets by utilizing the experiment planning method, 3:26175
DISTRICT HEATING/DESIGN
Problems of improving the methods of designing heat supply systems, 3:26545
DISTRICT HEATING/ECONOMICS
District heating as a task for government and economy. Existing networks to be extended systematically: special responsibilities for communities, 3:26508
DISTRICT HEATING/GOVERNMENT POLICIES
District heating as a task for government and economy. Existing networks to be extended systematically: special responsibilities for communities, 3:26508
DISTRICT HEATING/HEAT DISTRIBUTION SYSTEMS
Main means of improving designs of heating networks, 3:26548
Principles of arrangements of heating networks in towns, their automation, and remote control, 3:26549
DISTRICT HEATING/PLANNING
Principles of nuclear district heating, 3:26544
Some means of increasing efficiency of district heating in the tenth five-year period, 3:26546
DISTRICT HEATING/TOTAL ENERGY SYSTEMS
Unit-type power stations as elements for district heating. Principle: Heat-power coupling is systematically utilized, 3:26187
DIVERTORS/DESIGN
Compact poloidal divertor reference design for TNS, 3:27621 (WFPS-TME-055)
DIVERTORS/PLASMA DRIFT
Classical diffusion in the presence of an X point, 3:27638 (PPPL-EPRI-7)
DNA
(Deoxyribonucleic acid.)
DNA/BIOCHEMICAL REACTION KINETICS
Photorepair of uv damage to DNA: purification and properties of DNA photolyase (the DNA-photoreactivating enzyme). Progress and final reports, August 1, 1976-July 31, 1977, 3:26948 (ORO-3630-26)
Yeast mitochondrial DNA specifies tRNA for 19 amino acids. Deletion mapping of the tRNA genes, 3:26950
DNA/BIOLOGICAL REPAIR
Biological effects of ionizing radiation at the molecular, cellular, and organismal levals. Triannual progress report, July 15, 1974-October 14, 1977, 3:26984 (TID-28055)
Cellular heredity in haploid cultures of somatic cells. Annual progress report, April 1976-July 1977, 3:26960 (COO-3110-28)
Photorepair of uv damage to DNA: purification and properties of DNA photolyase (the DNA-photoreactivating enzyme). Progress and final reports, August 1, 1976-July 31, 1977, 3:26948 (ORO-3630-26)
DNA/BIOSYNTHESIS
Procedures for the detection of unscheduled DNA synthesis in the germ cells of mole mice exposed in vivo to chemical mutagens (^{3}H-dt tracer study), 3:26996 (TID-28142)
DNA/CHEMICAL REACTIONS
Electronic properties of n-heteroaromatics, LVII. Intermolecular interaction of the anti-tumor dye nile blue A and deoxyribonucleic acid (DNA), 3:26951 (LA-tr-77-66)
DNA/MEASURING METHODS
Impulse cytophotometric investigations on melanoblastoma, 3:26965 (LA-tr-78-2)
DODECANE/CATALYTIC CRACKING
Hydrocarbon cracking on amorphous and zeolithic cracking catalysts, 3:25764 (NP-22646)
DOLOMITE/CHEMICAL REACTIONS
Study of the mechanism of the hydrogen sulfide/dolomite reaction. Quarterly report, July 1977-October 1977, 3:25681 (FE-2408-5)
DOLOMITE/REGENERATION
Preparation of a coal conversion systems technical data book. Project 8979 quarterly report, May 1-July 31, 1977, 3:25633 (FE-2286-20)
DOSE DISTRIBUTIONS
See RADIATION DOSE DISTRIBUTIONS
DOSIMETRY
See also BETA DOSIMETRY
GAMMA DOSIMETRY
ION DOSIMETRY
NEUTRON DOSIMETRY
X-RAY DOSIMETRY
DOSIMETRY/DATA COMPILATION
Standardized radioactive decay data sets for use in radiation dosimetry, 3:26991 (IAEA-SM-222/51)
DRESDEN-1 REACTOR/COOLING PONDS
Effect of the severe winter upon a cooling pond fog study, 3:26213
DRESDEN-2 REACTOR/COOLING PONDS
Effect of the severe winter upon a cooling pond fog study, 3:26213
DRESDEN-3 REACTOR/COOLING PONDS
Effect of the severe winter upon a cooling pond fog study, 3:26213
DRIFT CHAMBERS/READOUT SYSTEMS
Drift chamber and pulse height readout systems using analog multiplexing, 3:26831 (SLAC-PUB-1844)

DRIFT INSTABILITY/STABILIZATION
Radial normal mode calculation of warm plasma stabilization of the drift cone mode, 3:27544
DRIFT INSTABILITY/VARIATIONAL METHODS
Theoretical investigations relevant to magnetic fusion energy research. Progress report, January 1, 1977-January 1, 1978, 3:27537 (CONF-771136-25)
DRILL CORES/MATHEMATICAL MODELS
Multifactor mathematical models of the core drilling-out process by lateral drilling core catchers, 3:25753
DRILL PIPES/DEFORMATION
Spiral deformation of a pipe string in a directional well, 3:25754
DRILL PIPES/STABILITY
Problem of stability of drill pipe strings, 3:25755
DRILLING EQUIPMENT
See also DRILL PIPES
DRILLING EQUIPMENT/OPERATION
Suction sticking of drilling tools, 3:25756
DRILLING FLUIDS/DIFFUSION
Percolation through clay crusts, 3:25762
DRILLING FLUIDS/FILTRATION
Investigation of the cake formation process under static filtration conditions, 3:25757
DRILLING MUD
See DRILLING FLUIDS
DRILLING PLATFORMS
See OFFSHORE PLATFORMS
DROPLETS/IGNITION
Theoretical and experimental investigation of the ignition of fuel droplets, 3:26702
DROPLETS/ROTATION
Use of boundary layer theory to determine the internal circulation of falling drops, 3:27092
DROSOPHILA/BIOLOGICAL INDICATORS
Literature survey of bacterial, fungal, and Drosophila assay systems used in the evaluation of selected chemical compounds for mutagenic activity, 3:26994 (ORNL/EMIC-9)
D-T REACTORS/PLASMA HEATING
Approximate theory of steady-state and dynamic characteristics of alpha-particle-heated DT-fusion reactors, 3:27462
DUALITY
(Correlation between resonance poles and scattering amplitudes.)
DUALITY/QUANTUM FIELD THEORY
More freedom now: an explanation of local duality and other mysteries, 3:27164
DUAL-PURPOSE POWER PLANTS/DISTRICT HEATING
Principles of nuclear district heating, 3:26544
Unit-type power stations as elements for district heating. Principle: Heat-power coupling is systematically utilized, 3:26187
DUAL-PURPOSE POWER PLANTS/ECONOMICS
Analysis of nuclear and coal fueled total energy system options for Fort Knox, Kentucky. Final technical report, June 1976-June 1977, 3:26338 (AD-A-043701)
DUAL-PURPOSE POWER PLANTS/PLANNING
New heat and power package is leaping over the final hurdle, 3:26188
DUODENUM
See SMALL INTESTINE
DWARF STARS/PULSATIONS
Cepheid pulsation theory and multiperiodic Cepheid variables (Review), 3:27022
DYE LASERS/CHEMICAL PREPARATION
Synthesis of the laser dyes, AC2F and AC3F, and related compounds. Research report, July-September 1976 and April-May 1977, 3:26720 (AD-A-042344)
DYE LASERS/DESIGN
Dye-based laser with high directionality of radiation, 3:26766
Explosively driven laser amplifier system (Patent), 3:26759
DYE LASERS/POWER
Correspondence between the calculated and experimental generated power of flashtube-pumped rhodamine lasers, 3:26748
DYES/CHEMICAL REACTIONS
Electronic properties of n-heteroaromatics, LVII. Intermolecular interaction of the anti-tumor dye nile blue A and deoxyribonucleic acid (DNA), 3:26951 (LA-tr-77-66)
DYNAMICS (BEAM)
See BEAM DYNAMICS
DYNAMITRONS/OPERATION
Physics Division annual review, 1 April 1976-31 March 1977 (ANL), 3:27312 (ANL-77-60)
DYSPROSIUM 156 TARGET/ALPHA REACTIONS
Coulomb excitation measurements of reduced E2 and E4 transition matrix elements in ^{156,158}Dy, ^{162,164}Er, and ^{168}Yb, 3:27374
DYSPROSIUM 158 TARGET/ALPHA REACTIONS
Coulomb excitation measurements of reduced E2 and E4 transition matrix elements in ^{156,158}Dy, ^{162,164}Er, and ^{168}Yb, 3:27374
DYSPROSIUM ALLOYS/ELECTRIC CONDUCTIVITY
Scattering of conduction electrons by spin disorder in rare-earth dysprosium-yttrium alloys, 3:26625
DYSPROSIUM COMPOUNDS/KNIGHT SHIFT
Systematics in the Knight shift of rare-earth monopnictides, 3:26600

E

EARTH ATMOSPHERE
See also AIR
IONOSPHERE
MAGNETOSPHERE
TROPOSPHERE
EARTH ATMOSPHERE/ELECTRON COLLISIONS
EXCEDE II. Environmental research papers, 3:27035 (AD-A-042491)
EARTH ATMOSPHERE/ENERGY ABSORPTION
ROSCOE manual. Volume 17. High-altitude debris-energy deposition. Final report, 1 March 1974-31 January 1975, 3:27040 (AD-A-043547)
EARTH ATMOSPHERE/ION-ION COLLISIONS
Investigation of ion-ion recombination cross sections. Scientific report No. 2 (annual) 19 October 1975-18 October 1976, 3:27033 (AD-A-042185)
EARTH ATMOSPHERE/MOLECULE COLLISIONS
Investigation of ion-ion recombination cross sections. Scientific report No. 2 (annual) 19 October 1975-18 October 1976, 3:27033 (AD-A-042185)
EARTH ATMOSPHERE/NEUTRAL-PARTICLE TRANSPORT
ROSCOE manual. Volume 16. High-altitude neutral-particle motion. Final report, 1 March 1974-31 January 1975 (> 90 km), 3:27039 (AD-A-043546)
EARTH ATMOSPHERE/TURBULENCE
Three velocity component, nonhomogeneous atmospheric boundary-layer turbulence modeling, 3:27031
EARTH CRUST/GROUND MOTION
Possible association between intensity of modern volcanism and horizontal movements of the crust in eastern Kamchatka, 3:27008
EARTH CRUST/HEAT FLOW
Flow of heat from the Earth's interior, 3:26108
Possible field variant for determining the earth heat flow by the method of temperature waves reduction (TWR), 3:26098
EARTH CRUST/PLATE TECTONICS
Flow of heat from the Earth's interior, 3:26108
EARTH CRUST/TECTONICS
Structural knots: important elements of structural boundaries of ancient platforms, 3:27007
EARTH MANTLE/GEOTHERMAL GRADIENTS
Temperature gradient of the upper mantle determined by the inversion of seismic data (abstract), 3:26111
EARTH MANTLE/HEAT FLOW
Radiogenic heat flow from the upper mantle of continental regions, 3:26113
EARTH PLANET/CLIMATES
Energy and the climate, 3:26868 (ORAU/IEA(M)-75-3)
EARTH PLANET/ENERGY BALANCE
Energy and the climate, 3:26868 (ORAU/IEA(M)-75-3)
EBR-2 REACTOR/LEAK DETECTORS
Sodium-to-gas leak detection. Annual technical progress report, government fiscal year 1977, 3:26275 (AI-DOE-13211)
EBULLATED BED/FLUID MECHANICS
Study of ebullated bed fluid dynamics for H-coal. Monthly progress report No. 4, December 1-December 31, 1977, 3:25659 (FE-2588-4)
EBULLATED BED/FUNCTIONAL MODELS
Study of ebullated bed fluid dynamics for H-coal. Monthly progress report No. 4, December 1-December 31, 1977, 3:25659 (FE-2588-4)
EBULLATED BED/MATHEMATICAL MODELS
Study of ebullated bed fluid dynamics for H-coal. Monthly progress report No. 4, December 1-December 31, 1977, 3:25659 (FE-2588-4)
ECCS
(Emergency core cooling system.)
ECCS/RELIABILITY
Phases mission analysis: a review of new developments and an application (BWR), 3:26221
ECOLOGICAL COMMUNITIES
See ECOSYSTEMS
ECOLOGY/BIBLIOGRAPHIES
Ecosystem models. Volume 2. November 1975-November 1977 (a bibliography with abstracts), 3:26990 (NTIS/PS-77/1011)

ECOLOGY/REVIEWS
Ecosystem paradigm for ecology, 3:26893 (ORAU-129)
ECONOMIC GROWTH/SIMULATION
ETA-MACRO: a model of energy-economy interactions (Simulates market economy through dynamic nonlinear optimization process), 3:26497 (EPRI-EA-592)
ECONOMY/TRADE
Energy shortage and price increases: effects on world economy and standard of living, 3:26501
ECOSYSTEMS
See also AQUATIC ECOSYSTEMS
TERRESTRIAL ECOSYSTEMS
ECOSYSTEMS/BIOLOGICAL MODELS
Ecosystem models. Volume 2. November 1975-November 1977 (a bibliography with abstracts), 3:26990 (NTIS/PS-77/1011)
EDDY CURRENTS
(Limited to electric currents.)
Eddy currents induced on the torus with non-uniform resistances, 3:27635 (JAERI-M-6953)
EFFLUENTS (CHEMICAL)
See CHEMICAL EFFLUENTS
EHD GENERATORS/JETS
Electrofluid dynamic generators and cycle performances for optimally matched injectors. Final technical report Sep 74-Jul 76, 3:26540 (AD-A-046120)
EHD GENERATORS/PERFORMANCE
Electrofluid dynamic generators and cycle performances for optimally matched injectors. Final technical report Sep 74-Jul 76, 3:26540 (AD-A-046120)
EHF RADIATION
See MICROWAVE RADIATION
EHV AC SYSTEMS/CONNECTORS
Flexible couplings between power plant main buildings and 500 kV open distribution units using lateral loops, 3:26201
ELASTIC SCATTERING/FORM FACTORS
Allowance for higher orders of the nuclear-surface deformation in calculations of elastic and inelastic nuclear form factors, 3:27395
ELECTRIC BATTERIES
(Devices for production and/or storage of electrical energy from chemical reactions; excludes FUEL CELLS and RADIOISOTOPE BATTERIES.)
See also LEAD-ACID BATTERIES
METAL-METAL BATTERIES
ELECTRIC BATTERIES/ECONOMICS
Batteries for utility load leveling, 3:26486
ELECTRIC BATTERIES/ELECTRODES
Electrode assembly for bipolar battery (With large thermal capacity for high discharge currents), 3:26491
ELECTRIC BATTERIES/ELECTROLYTES
Controlling the filling of alkaline batteries, 3:26492
ELECTRIC BATTERIES/PERFORMANCE TESTING
Batteries for utility load leveling, 3:26486
ELECTRIC BATTERIES/TECHNOLOGY ASSESSMENT
State-of-the-art assessment of electric and hybrid vehicles, 3:26580 (HCP/M1011-01)
ELECTRIC BATTERIES/TEST FACILITIES
Environmental assessment: Battery Energy Storage Test (BEST) Facility, Hillsborough, Somerset County, New Jersey, 3:26489 (DOE/EA-0001)
ELECTRIC BRIDGES/ERRORS
Phase-insensitive detectors for ac resistance bridges with application to temperature control systems, 3:26843 (Y/DA-7468)
ELECTRIC CABLES/SERVICE LIFE
Degradation of EMP hardening devices, 3:26841 (SAND-77-0841)
ELECTRIC CABLES/SHIELDING
Foil shielded flexible conduit (Patent), 3:26364
ELECTRIC CONTACTORS
See SWITCHES
ELECTRIC DISCHARGES/BREAKDOWN
Breakdown characteristics in presence of steady transverse magnetic fields, 3:27499
ELECTRIC DISCHARGES/STRIATIONS
Plasma physics mechanisms relevant to striation structuring and decay. part 1 - aspects of striation decay. Part 2. A synopsis of drift mode behavior. Part 3. Velocity shear, the E x B instability and the k to the -2nd power density spectrum. Final report 22 December 1975-21 December 1976, 3:27482 (AD-A-043571)
ELECTRIC FILTERS/SERVICE LIFE
Degradation of EMP hardening devices, 3:26841 (SAND-77-0841)
ELECTRIC GENERATORS
(Rotating generators only; excludes DIRECT ENERGY CONVERTERS.)
See also TURBOGENERATORS
GAC-ANL TNS scoping studies. Status report for FY-77, October 1, 1976-September 30, 1977. Volume XI. TNS doublet tokamak ohmic-heating power supply study. LA-7053-MS, 3:27648 (GA-A-14614(Vol.11))
ELECTRIC GENERATORS/STABILITY
Dynamic stability of hydraulic generators operating under the conditions of consumption of reactive capacity, 3:25981
ELECTRIC POWER
See also EPRI
HYDROELECTRIC POWER
Electricity generation by utilization of LNG-cold, 3:25839
ELECTRIC POWER/ALLOCATIONS
Real-time individual rationing as a response to an electricity shortage, 3:26525 (RAND-P-6006)
ELECTRIC POWER/CHARGES
Impacts of the national energy programme on solar economics, 3:26051 (LA-UR-78-131)
ELECTRIC POWER/DEMAND FACTORS
Methodology for predicting the demand for new electricity-using goods. Final report, 3:26498 (EPRI-EA-593)
ELECTRIC POWER INDUSTRY/RESEARCH PROGRAMS
Digest of current research in the electric utility industry (3000 entries), 3:26521 (EPRI-RD-3)
ELECTRIC POWER INDUSTRY/SIMULATION
Growth and adaptation processes in the power industry of the Federal Republic of Germany. A simulation model (Book, in German), 3:26526
ELECTRIC POWER RESEARCH INSTITUTE
See EPRI
ELECTRIC SWITCHES
See SWITCHES
ELECTRIC UTILITIES/BOILER FUEL
Annual summary of cost and quality of electric utility plant fuels, 1976, 3:25722 (TID-28133)
ELECTRIC UTILITIES/LEAD-ACID BATTERIES
Economic assessment of the utilization of lead-acid batteries in electric utility systems. Final report, 3:26522 (HCP/T2857-1)
ELECTRIC UTILITIES/LOAD MANAGEMENT
Impact of load management strategies upon electric utility costs and fuel consumption. Final report, 3:26198 (PB-271083)
System definition study: Phase 1 of individual load center, solar heating and cooling residential project. Final report (Impact of solar/load management systems on utilities), 3:26048 (EPRI-ER-594)
ELECTRIC UTILITIES/RESEARCH PROGRAMS
Digest of current research in the electric utility industry (3000 entries), 3:26521 (EPRI-RD-3)
ELECTRIC UTILITIES/STATISTICS
Statistics of publicly owned electric utilities in the United States, 3:26523 (NP-22952)
ELECTRIC UTILITIES/WASTE PRODUCT UTILIZATION
Overcoming institutional barriers to solid waste utilization as an energy source. Final report, 3:26531 (HCP/L50172-01)
Overcoming institutional barriers to solid waste utilization as an energy source. Executive summary, 3:26532 (HCP/L50172-02)
ELECTRICAL EQUIPMENT
See also ANTENNAS
ELECTRIC BRIDGES
RESISTORS
SWITCHES
Electrical design aspects for nuclear power plants, 3:26272
ELECTRICAL EQUIPMENT/CORROSION
Passivation and corrosion, 3:26785
ELECTRICAL EQUIPMENT/PASSIVATION
Passivation and corrosion, 3:26785
ELECTRICAL EQUIPMENT/PERFORMANCE TESTING
Environmental qualification of safety-related Class 1E process instrumentation, 3:26445 (WCAP-9211)
ELECTRICITY/CHARGES
Prospects for solar energy: the impact of the National Energy Plan (Economic analysis of solar space heating and solar water heating by state), 3:25985 (LA-7064-MS)
ELECTRIC-POWERED VEHICLES/ELECTRIC BATTERIES
Federal battery program for transportation uses, 3:26485 (CONF-7606127-1)
ELECTRIC-POWERED VEHICLES/LEAD-ACID BATTERIES
State-of-the-art lead-acid vehicle batteries, 3:26484 (ANL-K-77-3639-1)
ELECTRIC-POWERED VEHICLES/MEETINGS
Electric Hybrid Vehicle Program contractors' coordination meeting: summary, oversight, and review, 3:26581 (UCRL-13805)
ELECTRIC-POWERED VEHICLES/SILVER-ZINC BATTERIES
Research on alkaline zinc secondary electrodes with emphasis on life improvement. Annual progress report, June 15, 1976-March 15, 1977, 3:26490 (RLO/2434-1)
ELECTRIC-POWERED VEHICLES/SODIUM-SULFUR BATTERIES
European developments in the Na/S high- temperature battery for automobile propulsion and energy storage, 3:26487 (AD-A-042541)

ELECTRIC-POWERED VEHICLES/STANDARDS
Evaluation and recommendation of electric and hybrid vehicle performance standards. Final report, 3:26579 (CONS/5053-1)
ELECTRIC-POWERED VEHICLES/TECHNOLOGY ASSESSMENT
State-of-the-art assessment of electric and hybrid vehicles, 3:26580 (HCP/M1011-01)
ELECTRODYNAMICS
See also CHARGED-PARTICLE TRANSPORT
QUANTUM ELECTRODYNAMICS
ELECTRODYNAMICS/FREDHOLM EQUATION
Zeros of the Fredholm determinant for the external-field problem in Euclidean, massless spin-0 and spin-1/2 electrodynamics, 3:27266
ELECTROHYDRODYNAMIC GENERATORS
See EHD GENERATORS
ELECTROKINETICS
See ELECTRODYNAMICS
ELECTROMAGNETIC INTERACTIONS
See also ELECTROPRODUCTION
LEPTON-HADRON INTERACTIONS
PHOTON-PHOTON INTERACTIONS
ELECTROMAGNETIC INTERACTIONS/COUPLING CONSTANTS
Currents, quarks, and gluons, 3:27162
ELECTROMAGNETIC INTERACTIONS/MEETINGS
Weak and electromagnetic interactions at high energies. Part A, 3:27292
ELECTROMAGNETIC INTERACTIONS/REVIEWS
Electromagnetic interactions from 5 to 500 MeV and nuclear research: a position paper as of March 1977. Final report, 3:27168 (PB-270968)
ELECTROMAGNETIC RADIATION
See also LASER RADIATION
MICROWAVE RADIATION
VISIBLE RADIATION
X RADIATION
ELECTROMAGNETIC RADIATION/ABSORPTION
Negative absorption in an anisotropic plasma, 3:27589
ELECTROMAGNETIC RADIATION/BIBLIOGRAPHIES
Biological effects of nonionizing electromagnetic radiation. Volume II, Number 1. A digest of current literature. Quarterly report June-September 1977, 3:27000 (AD-A-043458)
ELECTROMAGNETIC RADIATION/BIOLOGICAL RADIATION EFFECTS
Biological effects of nonionizing electromagnetic radiation. Volume II, Number 1. A digest of current literature. Quarterly report June-September 1977, 3:27000 (AD-A-043458)
ELECTROMAGNETIC RADIATION/MODULATION
Modulation of electromagnetic waves in an isotropic inhomogeneous plasma, 3:27590
ELECTRON COLLISIONS
See also ELECTRON-ATOM COLLISIONS
ELECTRON-ION COLLISIONS
ELECTRON-MOLECULE COLLISIONS
ELECTRON COLLISIONS/RESEARCH PROGRAMS
Technical progress report, 1 July 1976-30 November 1977 (Summaries of research activities at California Institute of Technology), 3:27064 (CALT-767P4-161)
ELECTRON MICROSCOPY
Three-hour rapid processing technique for electron microscopy, 3:26957 (CONF-770504-)
ELECTRON MICROSCOPY/MEETINGS
Proceedings of the 14th annual electron microscopy colloquium, 3:26952 (CONF-770504-)
ELECTRON MICROSCOPY/USES
Recent advances in analytical electron microscopy, 3:26662 (CONF-770504-)
ELECTRON PLASMA WAVES/COUPLING
Plasma-wave coupling and propagation using phased waveguide arrays, 3:27582
ELECTRON PLASMA WAVES/WAVE PROPAGATION
Investigation of the transparency of the wave barrier for electron plasma waves in a magnetoactive plasma, 3:27586
Plasma-wave coupling and propagation using phased waveguide arrays, 3:27582
ELECTRON REACTIONS/ELASTIC SCATTERING
Elastic electron scattering from the multipole moment distributions of ^{25}Mg, 3:27343
Electron scattering from ^{204}Pb, ^{206}Pb, ^{207}Pb, ^{208}Pb (Bates Linac) (57.5 to 258 MeV, cross sections, J,π), 3:27377 (ORO-4043-37)
Electron scattering from ^{3}He and ^{4}He at high momentum transfer, 3:27378 (ORO-4043-37)
Threshold electrodisintegration and quasi-free scattering from ^{3}He (Counts per bin, preliminary results), 3:27322 (ORO-4043-37)
ELECTRON REACTIONS/INELASTIC SCATTERING
Electron scattering from ^{3}He and ^{4}He at high momentum transfer, 3:27378 (ORO-4043-37)
Investigation of giant multipole resonances in medium and heavy nuclei by inelastic electron scattering. Final technical report, 15 October 1974-31 October 1976, 3:27356 (AD-A-042298)
Threshold effects in the electrodisintegration of ^{3}He (Stanford Linac) (Monopoles, 170 to 300 MeV, cross section rapid rise), 3:27321 (ORO-4043-37)
ELECTRON REACTIONS/RESEARCH PROGRAMS
Experiments on the nuclear interactions of pions and electrons. Progress report, December 1, 1976-November 30, 1977 (Summaries of research activities at the University of Virginia), 3:27097 (ORO-4043-37)
ELECTRON-ATOM COLLISIONS/ELASTIC SCATTERING
Close-coupling calculations of electron scattering by atomic fluorine, 3:27074
Comments on the existence of low-energy d-wave resonances in electron-fluorine atom scattering, 3:27073
Time-of-flight spectrometer measurements of elastic-scattering cross sections for electrons with energies of 0.04-1.5 eV in He and Ne, 3:27081
ELECTRON-ATOM COLLISIONS/ENERGY-LEVEL TRANSITIONS
Continuum orbital approximations in weak-coupling theories for inelastic electron scattering, 3:27072
ELECTRON-ATOM COLLISIONS/EXCITATION
Measurement of the cross sections of copper atoms for excitation by electron impact, 3:27082
ELECTRON-ATOM COLLISIONS/INELASTIC SCATTERING
Continuum orbital approximations in weak-coupling theories for inelastic electron scattering, 3:27072
ELECTRON-ATOM COLLISIONS/IONIZATION
Angular distribution of electrons emitted in electron-impact ionization of helium atoms, 3:27083
Nonresonant and resonant electron distributions from fast particle collisions: Application to sodium, 3:27069
ELECTRONIC DATA PROCESSING
See DATA PROCESSING
ELECTRONIC EQUIPMENT
See also POWER SUPPLIES
ELECTRONIC EQUIPMENT/CORROSION
Passivation and corrosion, 3:26785
ELECTRONIC EQUIPMENT/PASSIVATION
Passivation and corrosion, 3:26785
ELECTRONIC EQUIPMENT/PHYSICAL RADIATION EFFECTS
Description of the code SCALID for calculating the one dimensional SGEMP boundary layer. Topical report, 3:26833 (AD-A-043519)
ELECTRONIC EQUIPMENT/RADIATION HARDENING
Degradation of EMP hardening devices, 3:26841 (SAND-77-0841)
ELECTRON-ION COLLISIONS/ENERGY-LEVEL TRANSITIONS
Continuum orbital approximations in weak-coupling theories for inelastic electron scattering, 3:27072
ELECTRON-ION COLLISIONS/EXCITATION
Distorted-wave theory of electron-ion collisions. I. Direct excitation and ionization, 3:27079
ELECTRON-ION COLLISIONS/INELASTIC SCATTERING
Continuum orbital approximations in weak-coupling theories for inelastic electron scattering, 3:27072
ELECTRON-ION COLLISIONS/IONIZATION
Distorted-wave theory of electron-ion collisions. I. Direct excitation and ionization, 3:27079
ELECTRON-MOLECULE COLLISIONS/ELASTIC SCATTERING
Rotational resonances in low-energy electron scattering by H_2 and D_2, 3:27071
ELECTRON-NEUTRON INTERACTIONS/INCLUSIVE INTERACTIONS
Electroproduction of inclusive pions at high Q^2 (Cross sections, feynmon scaling), 3:27104
ELECTRON-NUCLEON INTERACTIONS
See also ELECTRON-NEUTRON INTERACTIONS
ELECTRON-PROTON INTERACTIONS
ELECTROPRODUCTION
ELECTRON-NUCLEON INTERACTIONS/DEEP INELASTIC SCATTERING
Deep inelastic electron and muon scattering (Review), 3:27169 (SLAC-PUB-1613)
ELECTRON-POSITRON INTERACTIONS/ANNIHILATION
Can couplings of charged heavy leptons to the W^0 be measured, 3:27174
Differential dispersive analysis of e^+e^- annihilation into hadrons, 3:27180
e^+e^- annihilation into hadrons at SPEAR (Review, total cross sections, charged multiplicity), 3:27098 (SLAC-PUB-1624)
e^+e^- hadron production and jet structure at SPEAR (2.4 to 7.8 GeV, angular distribution), 3:27171 (SLAC-PUB-1814)
e^+e^- interactions (Total cross sections, lecture, review, scale invariance), 3:27170 (SLAC-PUB-1643)

Evidence for, and properties of the tau lepton (Cross sections), 3:27112 (SLAC-PUB-2055)
Gauge fields and strong interactions (Lectures), 3:27212
Gauge theories: an introduction (Review lectures, V-A theory, intermediate vector boson model), 3:27295
Hadrons (usual and newly discovered) in gauge theories a dream, 3:27213
Hydrodynamic model of collective resonances in hadronic matter, 3:27220
Inclusive baryon production in e^+e^- annihilation, 3:27103
Jet structure in e^+e^- annihilation as a test of quantum chromodynamics and the quark-confining string, 3:27176
Neutral heavy leptons and e^+e^- colliding-beam experiments, 3:27193
New states below 2.2 GeV observed in e^+e^- annihilations (1.35 to 2.2 GeV), 3:27136 (BNL-23612)
Nonresonant multibody production by e^+e^- annihilation (Jet-like structure, angular distribution, review cross sections), 3:27101 (SLAC-PUB-1745)
Phenomenology of electron positron annihilation into hadrons (Total cross sections, quarks, color), 3:27183
Production of new particles and muon-electron events in e^+-e^- annihilation at spear, 3:27100 (SLAC-PUB-1737)
Recent results on new particle production at SPEAR (Tau, π, mixing, mass, production cross sections), 3:27137 (SLAC-PUB-1998)
Retention of quantum numbers by quark and multiquark jets, 3:27159

ELECTRON-POSITRON INTERACTIONS/INCLUSIVE INTERACTIONS
e^+e^- annihilation into hadrons at SPEAR (Review, total cross sections, charged multiplicity), 3:27098 (SLAC-PUB-1624)
e^+e^- hadron production and jet structure at SPEAR (2.4 to 7.8 GeV, angular distribution), 3:27171 (SLAC-PUB-1814)
Nonresonant multibody production by e^+e^- annihilation (Jet-like structure, angular distribution, review cross sections), 3:27101 (SLAC-PUB-1745)
Phenomenology of electron positron annihilation into hadrons (Total cross sections, quarks, color), 3:27183

ELECTRON-POSITRON INTERACTIONS/PARTICLE PRODUCTION
Search for heavy particles, 3:27184 (SLAC-PUB-1891)

ELECTRON-POSITRON INTERACTIONS/TOTAL CROSS SECTIONS
e^+e^- hadron production and jet structure at SPEAR (2.4 to 7.8 GeV, angular distribution), 3:27171 (SLAC-PUB-1814)

ELECTRON-PROTON INTERACTIONS/ELASTIC SCATTERING
Recent developments in the theory of large transverse momentum processes, 3:27119 (SLAC-PUB-1806)

ELECTRON-PROTON INTERACTIONS/INCLUSIVE INTERACTIONS
Electroproduction of inclusive pions at high Q^2 (Cross sections, feynmon scaling), 3:27104

ELECTRONS
See also SOLVATED ELECTRONS

ELECTRONS/CHARGE DENSITY
Is an electron's charge independent of its velocity, 3:27150

ELECTRONS/ENERGY LOSSES
An investigation of 10 to the 12th power w per sq cm focused reb deposition of thick aluminum targets. Interim report, 3:27397 (AD-A-042211)

ELECTRONS/PARTICLE PRODUCTION
Observation of μe events in anti ν and ν interactions in neon, 3:27114

ELECTRONS/RADIATIVE CORRECTIONS
Status of the analytic calculations of QED sixth order radiative corrections to the electron anomaly, 3:27294

ELECTROPRODUCTION
See also ELECTRON-NUCLEON INTERACTIONS

ELECTROPRODUCTION/BOUNDARY CONDITIONS
More freedom now: an explanation of local duality and other mysteries, 3:27164

ELEMENTARY PARTICLES
See also HADRONS
LEPTONS
PHOTONS
STRANGE PARTICLES
Nuclear collisions at very high energy, 3:27147 (LBL-6597)

ELEMENTARY PARTICLES/BOUND STATE
Short review of methods used to compute bound states, 3:27167

ELMO BUMPY TORUS/SCALING LAWS
Simple neoclassical point model for transport and scaling in EBT, 3:27605

ELMO BUMPY TORUS/TRANSPORT THEORY
Simple neoclassical point model for transport and scaling in EBT, 3:27605

EMERGENCIES
See ACCIDENTS

EMERGENCY CORE COOLING SYSTEM
See ECCS

EMULSIONS/STABILITY
Electrolyte and pH effect on emulsion stability of water-in-petroleum oils, 3:25813

ENDOCRINE DISEASES/DIAGNOSTIC TECHNIQUES
Biomedical research and application utilizing cyclotron produced radionuclides. Progress report, January 1 1977-December 31, 1977, 3:26971 (COO/4268-1)

ENDOPLASMIC RETICULUM/MORPHOLOGICAL CHANGES
Structural variations of the endoplasmic reticulum of the jejunal mucosal cell, 3:26978 (CONF-770504-)

ENERGY
See also GEOTHERMAL ENERGY
SOLAR ENERGY

ENERGY/COST
Cost of energy over the next decade, 3:26499

ENERGY/RESEARCH PROGRAMS
Energy technology. Progress report, January-March 1977, 3:26504 (LA-6807-PR)

ENERGY ANALYSIS/IMPLEMENTATION
Net energy analysis: little progress and many problems, 3:26494 (EMD-77-57)

ENERGY ANALYSIS/PLANNING
Net energy analysis: little progress and many problems, 3:26494 (EMD-77-57)

ENERGY CONSERVATION
Energy conservation retrofit process for existing public and institutional facilities, 3:26510

ENERGY CONSERVATION/BUDGETS
Energy Resources Conservation and Development Commission 1978/79 budget, 3:26502

ENERGY CONSERVATION/REGULATIONS
Regulations establishing energy conservation standards for new nonresidential buildings, 3:26551

ENERGY CONSERVATION/RESEARCH PROGRAMS
Scenarios chemical technology (In German), 3:26555 (BMFT-FB-T-77-01)

ENERGY CONSERVATION/STANDARDS
Regulations establishing energy conservation standards for new nonresidential buildings, 3:26551

ENERGY CONSERVATION/TRIBOLOGY
Strategy for energy conservation through tribology, 3:26706 (TID-28175)

ENERGY CONSUMPTION/DATA COMPILATION
International energy trends: 3rd quarter 1977 and recent trends, 3:26528 (NP-23033)

ENERGY CONSUMPTION/FLOW MODELS
Energy systems and statistics, 3:26505 (LA-6807-PR)

ENERGY CONSUMPTION/REVIEWS
Alternatives to LNG in the United States, 3:26513

ENERGY DEMAND
Annual summary of cost and quality of electric utility plant fuels, 1976, 3:25722 (TID-28133)

ENERGY DEMAND/FORECASTING
National coal utilization assessment: the price and availability of low sulfur coal in eastern markets (Through 1985), 3:25719 (ANL/AA-12)
National coal utilization assessment: modeling long-term coal production with the Argonne coal market model, 3:25720 (ANL/AA-13)

ENERGY DEMAND/SIMULATION
Methodology for predicting the demand for new electricity-using goods. Final report, 3:26498 (EPRI-EA-593)

ENERGY FACILITIES/ECONOMIC IMPACT
Management of social and economic impacts associated with the construction of large-scale projects: experiences from the Western coal development communities, 3:26496 (BNWL-RAP-16)

ENERGY FACILITIES/ENVIRONMENTAL IMPACTS
Potential environmental impact of compounding and fabricating industries: a preliminary assessment. Final report, 3:26936 (PB-273603)
Technology facility siting characteristics and infrastructure needs. Final report, 3:26940 (PB-270899)

ENERGY FACILITIES/SOCIAL IMPACT
Management of social and economic impacts associated with the construction of large-scale projects: experiences from the Western coal development communities, 3:26496 (BNWL-RAP-16)

ENERGY FACILITIES/SOCIO-ECONOMIC FACTORS
Technology facility siting characteristics and infrastructure needs. Final report, 3:26940 (PB-270899)

ENERGY MODELS
Energy and Resource Planning Group FY 1977 annual report (Use of LLL Energy Model (LLLEM)), 3:26495 (UCRL-50029-77)
Methodology for predicting the demand for new electricity-using goods. Final report, 3:26498 (EPRI-EA-593)

ENERGY POLICY
See also NATIONAL ENERGY PLAN
National energy policy: an agenda for analysis, 3:26515 (EMD-77-16)
ENERGY SHORTAGES/ECONOMIC IMPACT
Energy shortage and price increases: effects on world economy and standard of living, 3:26501
ENERGY SHORTAGES/ELECTRIC POWER
Real-time individual rationing as a response to an electricity shortage, 3:26525 (RAND-P-6006)
ENERGY SOURCE DEVELOPMENT/ECONOMIC IMPACT
Management of social and economic impacts associated with the construction of large-scale projects: experiences from the Western coal development communities, 3:26496 (BNWL-RAP-16)
ENERGY SOURCE DEVELOPMENT/REGIONAL COOPERATION
Western States energy resource development update 1976, 3:26503
ENERGY SOURCE DEVELOPMENT/SOCIAL IMPACT
Management of social and economic impacts associated with the construction of large-scale projects: experiences from the Western coal development communities, 3:26496 (BNWL-RAP-16)
ENERGY SOURCES
See also FOSSIL FUELS
NUCLEAR FUELS
TIDAL POWER
WIND POWER
ENERGY SOURCES/BUDGETS
Energy Resources Conservation and Development Commission 1978/79 budget, 3:26502
ENERGY SOURCES/COMPARATIVE EVALUATIONS
Comparative effects of coal and nuclear fuel on mortality, 3:26871 (BNL-23579)
ENERGY SOURCES/ENVIRONMENTAL IMPACTS
Governmental promotion of technologies not harmful to the environment (Book, in German), 3:26518
ENERGY STORAGE
See also HYDROGEN STORAGE
MAGNETIC ENERGY STORAGE
OFF-PEAK ENERGY STORAGE
ENERGY STORAGE/MATERIALS
Role of materials in energy production, 3:26593
ENERGY SUPPLIES
Annual summary of cost and quality of electric utility plant fuels, 1976, 3:25722 (TID-28133)
ENERGY SUPPLIES/FORECASTING
National coal utilization assessment: the price and availability of low sulfur coal in eastern markets (Through 1985), 3:25719 (ANL/AA-12)
National coal utilization assessment: modeling long-term coal production with the Argonne coal market model, 3:25720 (ANL/AA-13)
Northwest Energy Policy Project. Energy supply and environmental impacts: conventional energy sources. Study Module III-A final report (1980 to 2000), 3:26512 (NP-23054)
ENERGY SUPPLIES/REVIEWS
Alternatives to LNG in the United States, 3:26513
ENGLAND
See UNITED KINGDOM
ENHANCED RECOVERY/RESEARCH PROGRAMS
Contracts and grants for cooperative research on enhanced oil and gas recovery and improved drilling methods. Progress review No. 12, 3:25745 (BERC-77/4)
ENRICHED URANIUM/ALLOCATIONS
Allocation of uranium enrichment services to fuel foreign and domestic nuclear reactors, 3:25915 (ID-75-45)
ENTOMOLOGY
See INSECTS
ENVIRONMENT/PLANNING
Previous scientific investigations, 1867-1967, 3:26899 (TID-26712)
ENVIRONMENT/RADIATION MONITORING
Validity and design of environmental surveillance systems for operating nuclear power plants. Final report, 3:26412 (EPRI-NP-604)
ENVIRONMENTAL TRANSPORT
See also ENVIRONMENT
RADIONUCLIDE MIGRATION
ENVIRONMENTAL TRANSPORT/COMPUTER CALCULATIONS
Corrections and revisions to the FORTRAN IV version of the Wisconsin Hydrologic Transport Model, 3:27003 (ORNL/NSF/EATC-29)
ENZYMATIC HYDROLYSIS/ECONOMICS
Cellulose, food and energy, 3:26021 (LBL-5275)
ENZYMES
See also LYASES
ENZYMES/BIOCHEMISTRY
Catalytic and structural properties of the pentafunctional/arom/ enzyme conjugate, 3:26944 (CONF-780108-1)
ENZYMES/BIOLOGICAL LOCALIZATION
Enzyme localizations in hepatocytes following triton WR-1339 injection, 3:26954 (CONF-770504-)
ENZYMES/MOLECULAR STRUCTURE
Catalytic and structural properties of the pentafunctional/arom/ enzyme conjugate, 3:26944 (CONF-780108-1)
EPIPHYSIS (BONES)
See BONE TISSUES
EPIPHYSIS (PINEAL GLAND)
See PINEAL GLAND
EPRI
See also ELECTRIC POWER
EPRI/INFORMATION SYSTEMS
Digest of current research in the electric utility industry (3000 entries), 3:26521 (EPRI-RD-3)
EPRI/RESEARCH PROGRAMS
Digest of current research in the electric utility industry (3000 entries), 3:26521 (EPRI-RD-3)
EPSILON RESONANCES
See ETA-700 RESONANCES
EQUATIONS (DIFFERENTIAL)
See DIFFERENTIAL EQUATIONS
EQUILIBRIUM PLASMA/FINITE ELEMENT METHOD
Finite element computation of plasma equilibria, 3:27502 (COO-2456-52)
ERBIUM 162 TARGET/ALPHA REACTIONS
Coulomb excitation measurements of reduced E2 and E4 transition matrix elements in ^{156,158}Dy, ^{162,164}Er, and ^{168}Yb, 3:27374
ERBIUM 164 TARGET/ALPHA REACTIONS
Coulomb excitation measurements of reduced E2 and E4 transition matrix elements in ^{156,158}Dy, ^{162,164}Er, and ^{168}Yb, 3:27374
ERBIUM COMPOUNDS/KNIGHT SHIFT
Systematics in the Knight shift of rare-earth monopnictides, 3:26600
ERYTHROCYTES/MORPHOLOGICAL CHANGES
Splenic remodeling of red cell surfaces, 3:26963
ERYTHROCYTES/PARASITES
Ultrastructure of Babesia equi and the parasitized equine erythrocyte, 3:26981 (CONF-770504-)
ESCA METHOD
See PHOTOELECTRON SPECTROSCOPY
ESCHERICHIA COLI/TEMPERATURE EFFECTS
Effects of high temperature on infections of E. coli B by bacteriophage T4D and its mutant in gene regA, 3:26976 (UR-3490/LCP-2)
ESCOM-1 REACTOR
See KOEBERG-1 REACTOR
ESTUARINE ECOSYSTEMS
See AQUATIC ECOSYSTEMS
ETA MESONS/INTERFERENCE
etaeta′ and ωphi mixing in the nonrelativistic quark model, 3:27179
ETA MESONS/PHOTOPRODUCTION
Asymmetry of the cross section of the photoproduction of eta mesons by polarized photons in the resonant energy region, 3:27105
ETA-549
See ETA MESONS
ETA-700 RESONANCES/DECAY
Simple symmetry breaking in a chiral SU(4) x SU(4) model of pseudoscalar mesons, 3:27199
ETA-958 RESONANCES/DECAY
Simple symmetry breaking in a chiral SU(4) x SU(4) model of pseudoscalar mesons, 3:27199
ETA-958 RESONANCES/INTERFERENCE
etaeta′ and ωphi mixing in the nonrelativistic quark model, 3:27179
1,2-ETHANEDIOL
See GLYCOLS
ETHANOL/BIOSYNTHESIS
Cellulose, food and energy, 3:26021 (LBL-5275)
Study of the fermentation of xylose to ethanol by fusarium oxysporum, 3:26022 (LBL-6351)
ETHYLENE GLYCOL
See GLYCOLS
EUGLENA/PHOTOSYNTHESIS
Effect of light on respiration and development of photosynthetic cells. Progress report, June 1, 1976-August 31, 1977 (Chlamydomonas, Euglena, spinach, peas), 3:26969 (COO-3231-5)
EUROPE
See also AUSTRIA
FRANCE
GERMAN FEDERAL REPUBLIC
ICELAND

ITALY
NETHERLANDS
SWITZERLAND
UNITED KINGDOM
USSR
EUROPE/HEAT FLOW
Correlation of heat flow and crustal structure in Europe (abstract), 3:26112
EUROPIUM 156/BETA-MINUS DECAY
Properties of the second K/sup π/+ band in ^{156}Gd, 3:27371
EUROPIUM COMPOUNDS/KNIGHT SHIFT
Systematics in the Knight shift of rare-earth monopnictides, 3:26600
EVACUATED TUBE COLLECTORS/DESIGN
Analysis of design changes necessary to adapt receiver to compound parabolic reflector. Final report, 3:26059 (ANL-K-3805-1)
EVAPORATORS/HEAT TRANSFER
Experimental investigation of heat transfer in a once-through regenerator-evaporator with a chemically reacting coolant (GOR), 3:26383
EVAPORATORS/MATHEMATICAL MODELS
Dynamic models of falling film evaporators for ocean thermal energy conversion plants, 3:26040 (COO/2641-3)
EXCHANGE MODELS
See PERIPHERAL MODELS
EXCURSIONS/FUEL ELEMENT FAILURE
Fracture mechanics of thin wall cylindrical pressure vessels: an interim review (LMFBR), 3:26442 (PNL-2417)
Summary and evaluation of fuel dynamics transient-overpower experiments: status 1974 (LMFBR), 3:26431 (ANL-77-44)
EXHAUST GASES/PURIFICATION
Complete catalytic oxidation of vapor mixtures containing phenol and hydrogen sulfide, 3:26678
Removal of sulfur dioxide from gases using activated carbon at elevated temperatures, 3:26668
EXOTIC ATOMS
See HADRONIC ATOMS
EXPERIMENTAL BREEDER REACTOR-2
See EBR-2 REACTOR
EXXON LIQUEFACTION PROCESS/PILOT PLANTS
EDS coal liquefaction process development, Phase III B. Monthly technical progress report, December 1-December 31, 1977, 3:25660 (FE-2893-6)
EXXON LIQUEFACTION PROCESS/RECOMMENDATIONS
Assessment of technology for the liquefaction of coal: summary, 3:25661 (FE/1216-2)
EYES/LASER RADIATION
Research on the ocular effects of laser radiation. Final report, 16 February 1975-30 November 1976, 3:26999 (AD-A-043457)

F

F-1260 RESONANCES/DECAY
Phenomenological model for charmed meson decay, 3:27221
F-1260 RESONANCES/PARTICLE PRODUCTION
Inclusive rho^0 and f^0 production in 100-GeV/c p anti p interactions, 3:27128
F-1514 RESONANCES/DECAY
Phenomenological model for charmed meson decay, 3:27221
F-1540 RESONANCES/DECAY
Phenomenological model for charmed meson decay, 3:27221
FAILED ELEMENT MONITORS/PERFORMANCE
Relation between fuel motion and detector response for in-core fuel motion detection systems, 3:26358 (SAND-77-0533C)
FAILED ELEMENT MONITORS/SPECIFICATIONS
Relation between fuel motion and detector response for in-core fuel motion detection systems, 3:26358 (SAND-77-0533C)
FALLOUT SHELTERS/DESIGN
Study of crisis utilization of large shelter space. Final report, 3:26712 (AD-A-046061)
FARADAY CUPS/DESIGN
Novel Faraday cup for the simultaneous observation and measurement of ion-beam currents, 3:27055 (COO-3158-55)
FARADAY CUPS/PERFORMANCE
Novel Faraday cup for the simultaneous observation and measurement of ion-beam currents, 3:27055 (COO-3158-55)
FARADAY GENERATORS
See MHD GENERATORS
FAST FLUX TEST FACILITY REACTOR
See FFTF REACTOR
FAST REACTORS
See also FFTF REACTOR
GCFR TYPE REACTORS
LMFBR TYPE REACTORS
FAST REACTORS/FUEL ELEMENTS
Fuel element for fast nuclear reactors (Patent), 3:26328
FASTENERS/DESIGN
Screwing and holding device for lock nuts, especially for screwed joints of reactor pressure vessels (Patent), 3:26369
FASTENERS/ULTRASONIC TESTING
Device for ultrasonic material testing of bolts having an axial through hole, preferably stud bolts of nuclear reactor pressure vessels (Patent), 3:26385
FAULT TREE ANALYSIS
New methodology for the computer-aided construction of fault trees, 3:26472
FAULT TREE SYSTEMS
See FAULT TREE ANALYSIS
FEDERAL REPUBLIC OF GERMANY
See GERMAN FEDERAL REPUBLIC
FEEDWATER/DEMINERALIZATION
Mixed-bed system with outer regeneration, 3:26373
FEEDWATER/WATER TREATMENT
Stabilization treatment of return cooling water with phosphonates, 3:26158
FEEDWATER HEATERS
Feed water pre-heater with two steam spaces (Patent), 3:26224
FEEDWATER HEATERS/HEAT TRANSFER
Effect of thermal resistance of network water heaters on the operation of a t-250/300-240 turbine plant in variable conditions, 3:26179
FERMILAB ACCELERATOR/COLLIDING BEAMS
Comparison of anti p anti p and pp luminosities at Fermilab, 3:27215 (ANL-HEP-CP-77-81)
Crossing geometry for Main Ring on Doubler collisions, 3:26802 (ANL-HEP-CP-77-60)
FERMIONS
See also BARYONS
LEPTONS
FERMIONS/DECAY
Radiative decays of fermions and the mass of the photon, 3:27178
FERMIONS/ENERGY SPECTRA
Spectra of fermions in monopole fields: Exactly soluble models, 3:27269
FERMIONS/VACUUM STATES
Pseudoparticles and massless fermions in two dimensions, 3:27158
FESHBACH-PORTER-WEISSKOPF MODEL
See OPTICAL MODELS
FESSENHEIM-2 REACTOR/REACTOR COMMISSIONING
Commissioning of a nuclear power plant, 3:26248
FEYNMAN DIAGRAM/EIKONAL APPROXIMATION
Relativistic eikonal expansion, 3:27153
FFTF REACTOR/REACTOR COMPONENTS
Sodium technology and cover gas seal development programs. Quarterly technical progress report, July-September 1977, 3:26274 (AI-DOE-13208)
FFTF REACTOR/REACTOR COOLING SYSTEMS
Sodium technology and cover gas seal development programs. Quarterly technical progress report, July-September 1977, 3:26274 (AI-DOE-13208)
FFTF REACTOR/REACTOR SAFETY
FSAR amendment 10, 3:26436 (HEDL-TI-75002-10)
Safety aspects of carbide irradiations in FTR driver positions, 3:26476
FIBERS/MATERIALS RECOVERY
Cryogenic tire granulation, 3:26573
FIBERS/PHYSICAL RADIATION EFFECTS
Effects of fast and thermal neutron flux and gamma radiation on the transmission characteristics of optical fibers. Interim report, 3:26659 (AD-A-042429)
FIBERS/RADIATION HARDENING
State of the art in fiber optics communications and data transfer. Interim report, 3:26660 (AD-A-042579)
FIELD ALGEBRA
Field theory (Book), 3:27418
FIELD EQUATIONS/SOLITONS
Pulsating solitons, 3:27284
FIELD THEORIES
See also QUANTUM FIELD THEORY
FIELD THEORIES/DUALITY
Gauge-invariant formulation of the self-dual sector, 3:27261
FIELD THEORIES/GAUGE INVARIANCE
(2 + 1) -dimensional Abelian lattice gauge theory, 3:27268
Gauge-invariant formulation of the self-dual sector, 3:27261
FIELD THEORIES/SEMICLASSICAL APPROXIMATION
Pulsating solitons, 3:27284
FIELD THEORIES/SOLITONS
Pulsating solitons, 3:27284
FIELD THEORIES/STRING MODELS
Field theories in terms of particle-string variables: Spin, internal symmetries, and arbitrary dimension, 3:27274

FIELD-REVERSED MIRROR REACTOR/PLASMA MICROINSTABILITIES
Theoretical investigations relevant to magnetic fusion energy research. Progress report, January 1, 1977-January 1, 1978, 3:27537 (CONF-771136-25)
FIRE EXTINGUISHERS/PERFORMANCE
Extinction of metal fires, 3:26471
FIRST WALL/MATERIALS TESTING
Comparison of liquid ISSECs; Li, Pb, and Pb_4Li for use in laser fusion reactors, 3:27620 (UWFDM-208)
Effect of a liquid ISSEC on radiation damage parameters in laser fusion reactor first walls, 3:27619 (UWFDM-205)
Use and performance of graphite and metal ISSECs in tokamak fusion reactors, 3:27618 (UWFDM-202)
FIRST WALL/WALL LOADING
Fusion product bombardment of a tokamak first wall, 3:27626
FISHES/COMMUNITIES
Marine fish communities, 3:26927 (TID-26712)
FISHES/TAXONOMY
Marine fish communities, 3:26927 (TID-26712)
FISHING INDUSTRY/REGULATIONS
Fishery resources of the western Aleutians, 3:26937 (TID-26712)
FISSION ISOMERS/REVIEWS
Experimental investigation of spontaneously fissile isomers, 3:27386
FISSION ISOMERS/SPONTANEOUS FISSION
Experimental investigation of spontaneously fissile isomers, 3:27386
FISSION POISONS
Material for shutting down gas cooled nuclear reactors (Patent), 3:26407
FISSION PRODUCT RELEASE/MATHEMATICAL MODELS
COPAR, a program to compute release of metallic fission products from coated particles (HTGR), 3:26254 (GA-A-14034)
FISSIONABLE MATERIALS MANAGEMENT
See NUCLEAR MATERIALS MANAGEMENT
FLAMES/ABSORPTION SPECTROSCOPY
Laser spectroscopy for continuous combustion applications, 3:26700 (BMI-1982)
FLAMES/FLUORESCENCE SPECTROSCOPY
Laser spectroscopy for continuous combustion applications, 3:26700 (BMI-1982)
FLAMES/STABILITY
Development of combustion data to utilize low-Btu gases as industrial process fuels. Project 8985 monthly status report, November 1-November 30, 1977, 3:25712 (FE-2489-18)
FLAMES/TEMPERATURE MEASUREMENT
Laser spectroscopy for continuous combustion applications, 3:26700 (BMI-1982)
FLASH TUBES/DESIGN
K-RB laser pump lamp. Final technical report Nov 73-Feb 75, 3:26734 (AD-B-009019)
FLAT PLATE COLLECTORS/ANTIREFLECTION COATINGS
Optimization of coatings for flat plate solar collectors, Phase II. Final report, 28 June 1976-27 June 1977, 3:26060 (COO-2930-12)
FLAT PLATE COLLECTORS/BLACK COATINGS
Improved black nickel coatings for flat plate solar collectors, 3:26072
Optimization of coatings for flat plate solar collectors, Phase II. Final report, 28 June 1976-27 June 1977, 3:26060 (COO-2930-12)
FLAT PLATE COLLECTORS/COATINGS
Optimization of coatings for flat plate solar collectors, Phase II. Final report, 28 June 1976-27 June 1977, 3:26060 (COO-2930-12)
FLAT PLATE COLLECTORS/DIPPED COATINGS
Optimization of coatings for flat plate solar collectors, Phase II. Final report, 28 June 1976-27 June 1977, 3:26060 (COO-2930-12)
FLAT PLATE COLLECTORS/EFFICIENCY
Method for evaluating the solar energy provided by a flat insolator, 3:26065
FLAT PLATE COLLECTORS/PERFORMANCE
Solar house heating system using reflective pyramid optical condensing system. Final report. Evaluation of performance, June 1, 1975-December 31, 1976, 3:26045 (COO/2769-2)
FLAT PLATE COLLECTORS/SPECTRALLY SELECTIVE SURFACES
Optimization of coatings for flat plate solar collectors, Phase II. Final report, 28 June 1976-27 June 1977, 3:26060 (COO-2930-12)
FLAVOR MODEL/WEAK NEUTRAL CURRENTS
Flavor conservation in an SU(3) x U(1) x U(1) model, 3:27198
FLOWMETERS/CALIBRATION
Sodium flow calibration using a pulsed neutron activation technique on a 400mm (16 inch) pipe at LMEC, 3:26278 (ANL-CT-78-9)
FLUE GAS/CLEANING
CFCC Development Program. Monthly report, November 1977, 3:26142 (FE-2357-19)
Coal Creek Station steam generators, 3:26130 (GFERC/IC-77/1)
FLUE GAS/DENITRIFICATION
Influence of exhaust gas recirculation on the formation of nitrogen oxides during the burning of oil, 3:26195
Studies on nitrogen oxides removal from flue gas (No. 2), 3:26196
FLUE GAS/DESULFURIZATION
Application of scrubbing systems to low sulfur/alkaline ash coals. Final report, 3:25678 (EPRI-FP-595)
Catalytic oxidation of calcium sulfite during removal of SO_2 from flue gases by the limestone method, 3:26787
State-of-the-art of FGD sludge fixation. Final report, 3:25680 (EPRI-FP-671)
Status of flue gas desulfurization applications in the United States: a technological assessment, 3:26194 (TID-28141)
Studies on nitrogen oxides removal from flue gas (No. 2), 3:26196
Survey of the application of flue gas desulfurization technology in the industrial sector, 3:26786 (PB-270548)
FLUE GAS/FILTRATION
Panel bed filter. Final report, 3:25677 (EPRI-AF-560)
FLUE GAS/SCRUBBING
Application of scrubbing systems to low sulfur/alkaline ash coals. Final report, 3:25678 (EPRI-FP-595)
Summary of the effects of important chemical variables upon the performance of lime/limestone wet scrubbing systems. Interim report, 3:25679 (EPRI-FP-639)
FLUID MECHANICS
See also HYDRODYNAMICS
FLUID MECHANICS/NUMERICAL SOLUTION
SIMPLE code (Solution of equations of inviscid compressible hydrodynamics and simple heat conduction), 3:26770 (UCID-17715)
FLUIDIZATION/RESEARCH PROGRAMS
Improved techniques for gasifying coal. Fourth quarterly report, April 1-June 30, 1977, 3:25635 (FE-2340-4)
FLUIDIZED-BED COMBUSTION/ADSORBENTS
Preparation of a coal conversion systems technical data book. Project 8979 quarterly report, May 1-July 31, 1977, 3:25633 (FE-2286-20)
Regeneration of lime-based sorbents in a kiln with solid reductants, 3:25710 (BNL-23765)
FLUIDIZED-BED COMBUSTION/DEMONSTRATION PLANTS
Industrial application of fluidized-bed combustion: Phase I. Quarterly report, July 1-September 30, 1977 (Cold-flow model), 3:26779 (FE-2473-15)
FLUIDIZED-BED COMBUSTION/EXHAUST GASES
Experimental studies on fluidized-bed combustion (1st report), 3:26781
FLUIDIZED-BED COMBUSTION/PROCESS DEVELOPMENT UNITS
Industrial application of fluidized-bed combustion: Phase I. Quarterly report, July 1-September 30, 1977 (Cold-flow model), 3:26779 (FE-2473-15)
FLUIDIZED-BED COMBUSTION/RESEARCH PROGRAMS
Experimental studies on fluidized-bed combustion (1st report), 3:26781
Project acquisition and evaluation process for Atmospheric Fluidized Bed Combustion demonstration plant, 3:26780 (FE/2343-1)
FLUIDIZED-BED COMBUSTORS/AIR POLLUTION ABATEMENT
Mathematical modelling of coal combustion in fluidized beds with sulphur emission control by limestone or dolomite, 3:25717
FLUIDIZED-BED COMBUSTORS/DEMONSTRATION PLANTS
Project acquisition and evaluation process for Atmospheric Fluidized Bed Combustion demonstration plant, 3:26780 (FE/2343-1)
FLUIDIZED-BED COMBUSTORS/DESIGN
Centrifugal fluidized combustion of coal. Annual report for period ending September 1977, 3:25713 (FE-2516-4)
Evaluation of a pressurized-fluidized bed combustion (PFBC) combined cycle power plant conceptual design. Quarterly report, July 1-September 30, 1977, 3:26143 (FE-2371-20)
Industrial application of fluidized-bed combustion: Phase I. Quarterly report, July 1-September 30, 1977 (Cold-flow model), 3:26779 (FE-2473-15)
FLUIDIZED-BED COMBUSTORS/TESTING
Centrifugal fluidized combustion of coal. Annual report for period ending September 1977, 3:25713 (FE-2516-4)
FLUORESCENCE SPECTROSCOPY/EQUIPMENT
Laser spectroscopy for continuous combustion applications, 3:26700 (BMI-1982)
Laser two-proton excited fluorometric detection for high pressure liquid chromatography, 3:26837 (IS-T-792)
FLUORINE/ELECTRON-ATOM COLLISIONS
Close-coupling calculations of electron scattering by atomic fluorine, 3:27074
Comments on the existence of low-energy d-wave resonances in electron-fluorine atom scattering, 3:27073

FLUORINE/HEAVY ION REACTIONS
Proton and pion spectra at large angles in relativistic heavy-ion collisions (800 MeV/N), 3:27332 (LBL-670)
FLUORINE/QUANTITATIVE CHEMICAL ANALYSIS
Fate of trace and minor constituents of coal during gasification. Final task report, 3:25641 (PB-270913)
FLUORINE 18/BLOOD-PLASMA CLEARANCE
Investigation of ^{18}F-2-deoxyglucose for the measure of myocardial glucose metabolism, 3:26993 (UCLA-12-1142)
FLUORINE 18/RETENTION
Investigation of ^{18}F-2-deoxyglucose for the measure of myocardial glucose metabolism, 3:26993 (UCLA-12-1142)
FLUORINE 18/UPTAKE
Investigation of ^{18}F-2-deoxyglucose for the measure of myocardial glucose metabolism, 3:26993 (UCLA-12-1142)
FLUORINE 19 TARGET/PION MINUS REACTIONS
Neutron and proton knockout from ^{19}F and ^{27}Al by negative pions, 3:27329
FLUORINE COMPOUNDS/SYNTHESIS
Laser synthetic chemistry (SF_6NF_2), 3:26692 (LA-UR-77-2790)
FLUX CORED ARC WELDING
See ARC WELDING
FLY ASH/CHEMICAL ANALYSIS
Carbon analysis in fly ash, 3:25685
Method and equipment for the continuous determination of the content of burnable components in powder form bulk goods (Patent), 3:26663
FLY ASH/CHEMICAL COMPOSITION
Production of forty percent core area flyash brick using a lignite flyash, a northern West Virginia flyash, and a western Kentucky flyash. Report No. 112, 3:25682 (NP-23088)
FLY ASH/CHEMICAL REACTIONS
Regeneration of lime-based sorbents in a kiln with solid reductants, 3:25710 (BNL-23765)
FLY ASH/PH VALUE
Application of scrubbing systems to low sulfur/alkaline ash coals. Final report (Fly ash as scrubber reagent), 3:25678 (EPRI-FP-595)
FLY ASH/PHYSICAL PROPERTIES
Effect of regime parameters of boiler operation on abrasive properties of Ekibastuz coal ash, 3:26167
FLY ASH/USES
Panel bed filter. Final report, 3:25677 (EPRI-AF-560)
FLY ASH/WASTE PRODUCT UTILIZATION
Carbon analysis in fly ash, 3:25685
Production of forty percent core area flyash brick using a lignite flyash, a northern West Virginia flyash, and a western Kentucky flyash. Report No. 112, 3:25682 (NP-23088)
Study of the effect of firing conditions upon flyash structural products. Report No. 128, 3:25683 (NP-23089)
FOOD
See also MILK
FOOD/PRODUCTION
Cellulose, food and energy, 3:26021 (LBL-5275)
FOOD INDUSTRY/ENERGY CONSUMPTION
Energy use in the dairy industry (report No. 25), 3:26529 (NP-23050)
FORBIDDEN TRANSITIONS/P INVARIANCE
Calculation of parity-nonconserving effects in forbidden M1 transitions in cesium, 3:27054
FORMALDEHYDE/CHEMICAL REACTION KINETICS
Rate parameters for the reactions of formaldehyde with H-atoms and O-atoms over the temperature range 250 to 470 K, 3:26670 (BNL-23550)
FORSCHUNGSREAKTOR BERLIN-2
See BER-2 REACTOR
FORT ST. VRAIN REACTOR
See VRAIN REACTOR
FOSSIL FUELS
See also COAL
NATURAL GAS
PETROLEUM
SYNTHETIC FUELS
FOSSIL FUELS/AIR POLLUTION ABATEMENT
Advanced fossil fuel and the environment: an executive report, 3:26192 (EPA-600/9-77-013)
FOSSIL FUELS/RESERVES
Cost of energy over the next decade, 3:26499
FOSSIL-FUEL POWER PLANTS/AIR HEATERS
Investigation of contamination and corrosion of regenerative air preheaters during combustion of Ekibastuz coal, 3:26166
FOSSIL-FUEL POWER PLANTS/BOILER FUEL
Future use of coal in energy generation, 3:25723
FOSSIL-FUEL POWER PLANTS/BOILERS
Boiler for an 800 MW power block fired by Ekibastuz coal, 3:26165
Experience of operation and results of tests of TP-100 and TP-100A boilers with open-loop pulverized fuel systems designed by tckti, 3:26140
Improvement of the design of Type P-57 boiler relying on the experience of its operation at the troitskaya district power station, 3:26164
FOSSIL-FUEL POWER PLANTS/CAPITAL
Combined cycle power plant, capital cost estimates. Final report, 3:26189 (EPRI-AF-610)
FOSSIL-FUEL POWER PLANTS/CHEMICAL EFFLUENTS
Comparative effects of coal and nuclear fuel on mortality, 3:26871 (BNL-23579)
FOSSIL-FUEL POWER PLANTS/COAL PREPARATION
Analysis of pulverized fuel preparation systems equipped with different mills, for an 800 mw block fired by Kansk-Achinsk coal varieties, 3:25709
FOSSIL-FUEL POWER PLANTS/COMPARATIVE EVALUATIONS
Impact on the employment situation of the construction and operation of power plants, 3:26500
Role for nuclear energy in the recovery of oil from the tar sands of Alberta, 3:25894
FOSSIL-FUEL POWER PLANTS/COST
Combined cycle power plant, capital cost estimates. Final report, 3:26189 (EPRI-AF-610)
User's instructions for preliminary version of the CONCEPT-5 computer code (For cost estimation of coal-fired and nuclear power plants, in FORTRAN for IBM 360/95), 3:26190 (ORNL/TM-6230)
FOSSIL-FUEL POWER PLANTS/ELECTROSTATIC PRECIPITATORS
Coal Creek Station steam generators, 3:26130 (GFERC/IC-77/1)
FOSSIL-FUEL POWER PLANTS/FLUE GAS
Influence of exhaust gas recirculation on the formation of nitrogen oxides during the burning of oil, 3:26195
Status of flue gas desulfurization applications in the United States: a technological assessment, 3:26194 (TID-28141)
FOSSIL-FUEL POWER PLANTS/GAS TURBINES
Closed gas turbine heater program. Second quarterly technical progress report, July 4, 1977-October 2, 1977, 3:26149 (TID-28200)
FOSSIL-FUEL POWER PLANTS/HEALTH HAZARDS
Population hazards associated with fossil fuel and nuclear power production, 3:26419
FOSSIL-FUEL POWER PLANTS/POLLUTION CONTROL EQUIPMENT
Energy consumption of environmental controls: fossil fuel, steam electric generating industry. Final report, 3:26193 (PB-273019)
FOSSIL-FUEL POWER PLANTS/RADIOACTIVE EFFLUENTS
Comparative effects of coal and nuclear fuel on mortality, 3:26871 (BNL-23579)
FOSSIL-FUEL POWER PLANTS/SCRUBBERS
Application of scrubbing systems to low sulfur/alkaline ash coals. Final report (Fly ash as scrubber reagent), 3:25678 (EPRI-FP-595)
Coal Creek Station steam generators, 3:26130 (GFERC/IC-77/1)
State-of-the-art of FGD sludge fixation. Final report, 3:25680 (EPRI-FP-671)
FOSSIL-FUEL POWER PLANTS/SOCIAL IMPACT
Impact on the employment situation of the construction and operation of power plants, 3:26500
FOSSIL-FUEL POWER PLANTS/STEAM GENERATORS
Coal Creek Station steam generators, 3:26130 (GFERC/IC-77/1)
Corrosivity of flue gases from supercritical steam generators in operation on high-sulfur oil, 3:26155
Effectiveness of high-sulfur oil combustion within range of loads in the furnace of the TGMP-314 steam generator, 3:26154
Optimal maintenance of main steam parameters in accordance with load of a generating unit, 3:26156
FOSSIL-FUEL POWER PLANTS/STEAM TURBINES
Investigation of cooling-down conditions of the K-200-130 turbine of a drum boiler-type power block, 3:26172
Steam turbines, 3:26367
FOSSIL-FUEL POWER PLANTS/TOPPING CYCLES
Comparative evaluation of the technical and economic indices of MHD and thermionic add-on units for steam-turbine power plants, 3:26150 (JPRS-69811)
FOUR-BODY PROBLEM/LIPPMANN-SCHWINGER EQUATION
New equations for four-body scattering, 3:27310
FRANCE/LMFBR TYPE REACTORS
French advanced fuels development program (LMFBR), 3:26296
FRANCE/THERMAL SPRINGS
Attempted geothermometric determination of maxima subsurface water temperatures of main hydrothermic areas of Languedoc-Roussillon and Pyrenees-Orientales, 3:26101
FREE RADICALS
See RADICALS
FRESH WATER ECOSYSTEMS
See AQUATIC ECOSYSTEMS
FT. CALHOUN-1
See CALHOUN-1 REACTOR

FTR REACTOR
See FFTF REACTOR
FUEL ASSEMBLIES
See also FUEL ELEMENT CLUSTERS
FUEL ASSEMBLIES/HEAT TRANSFER
Analysis of the feasibility of implementing an implicit temporal differencing scheme in the SUPERENERGY code (LMFBR), 3:26279 (COO-2245-35TR)
FUEL ASSEMBLIES/HYDRAULICS
Analysis of the feasibility of implementing an implicit temporal differencing scheme in the SUPERENERGY code (LMFBR), 3:26279 (COO-2245-35TR)
FUEL ASSEMBLIES/NEUTRON FLUX
FLEX: a code for calculating neutron flux microdistributions in lattices consisting of hexagonal fuel assemblies, 3:26346
FUEL ASSEMBLIES/SPACERS
Spacer for nuclear reactor fuel rods, 3:26398
Spacers for fuel elements with a large number of fuel rods (Patent), 3:26400
FUEL ASSEMBLIES/TEMPERATURE DISTRIBUTION
Approximate method for predicting temperature distribution in wire wrapped fuel assemblies of a LMFBR, 3:26280 (COO-2245-37TR)
FUEL BUNDLES
See FUEL ELEMENT CLUSTERS
FUEL CANS
Fuel rod for liquid metal-cooled nuclear reactors (Patent), 3:26329
FUEL CANS/DEFORMATION
Application of finite element method to ring compression test, 3:26387
FUEL CANS/FRACTURE PROPERTIES
Fracture mechanics of thin wall cylindrical pressure vessels: an interim review (LMFBR), 3:26442 (PNL-2417)
FUEL CANS/PERFORMANCE TESTING
Status of international fuel cladding development (LMFBR), 3:26326
FUEL CANS/PHYSICAL RADIATION EFFECTS
Status of international fuel cladding development (LMFBR), 3:26326
FUEL CANS/PROTECTIVE COATINGS
Fuel element (Patent), 3:26401
Fuel element (Patent), 3:26402
FUEL CANS/ULTRASONIC TESTING
Experience with a new ultrasonic inspection system for non-destructive examination of precision tubes, 3:26388
FUEL CELL POWER PLANTS/RESEARCH PROGRAMS
Advanced technology fuel cell program. Interim report, 3:26543 (EPRI-EM-576)
FUEL CYCLE
See also FUEL MANAGEMENT
FUEL CYCLE/ENVIRONMENTAL IMPACTS
SNR-carbide program: its position between present and future, 3:26295
FUEL CYCLE/INTERNATIONAL COOPERATION
Regional nuclear fuel cycle centres. IAEA study project, 3:25955
FUEL CYCLE/PLANNING
Development of advanced fuels in Switzerland (LMFBR), 3:26298
SNR-carbide program: its position between present and future, 3:26295
FUEL ECONOMY/DEMONSTRATION PROGRAMS
Diagnostic motor vehicle inspection demonstration projects, program engineering support. Volume 7. Appendix f. Fuel economy evaluation. Final report November 1974-December 1976, 3:26587 (PB-270995)
FUEL ELEMENT CLUSTERS
Fuel element assembly (Patent), 3:26223
Fuel rod bundles for nuclear reactors (Patent), 3:26403
FUEL ELEMENT CLUSTERS/REMOTE HANDLING EQUIPMENT
Device for dismounting fuel elements (Patent), 3:26389
FUEL ELEMENT CLUSTERS/SUPPORTS
Fuel assembly for a nuclear reactor (Patent), 3:26330
Improved support for nuclear fuel rods (Patent), 3:26394
FUEL ELEMENT FAILURE
Advanced fuels safety comparisons (LMFBR), 3:26477
Case for fuel redesign after in pile safety experiments: the "COMMANDO" tests (LMFBR), 3:26315
Experimental study of advanced fuel-pin failure phenomena (LMFBR), 3:26313
GFEK experimental approach to carbide fuel element licensing (LMFBR), 3:26314
FUEL ELEMENT FAILURE/MATHEMATICAL MODELS
Fracture mechanics of thin wall cylindrical pressure vessels: an interim review (LMFBR), 3:26442 (PNL-2417)
FUEL ELEMENT FAILURE/RESEARCH PROGRAMS
U.S. advanced fuels safety program (LMFBR), 3:26312
FUEL ELEMENT FAILURE/SIMULATION
Summary and evaluation of fuel dynamics transient-overpower experiments: status 1974 (LMFBR), 3:26431 (ANL-77-44)
FUEL ELEMENTS
See also FUEL ASSEMBLIES
FUEL CANS
FUEL PINS
FUEL RODS
NUCLEAR FUELS
Fuel element for fast nuclear reactors (Patent), 3:26328
Nuclear fuel element and method for its production (Patent), 3:26396
Rod-shaped fuel element for nuclear reactors (Patent), 3:26391
Safety device in a nuclear reactor fuel rod with a closed fission gas plenum (Patent), 3:26327
FUEL ELEMENTS/HEAT TRANSFER
Finite element nonlinear heat transfer analysis using a stable explicit method, 3:26349
FUEL ELEMENTS/NEUTRON RADIOGRAPHY
Neutron radiography experiments at JRR-4, (2). Neutron radiography of simulated mixed-oxide fuels, 3:26390
FUEL ELEMENTS/SPACERS
Cell-shaped fuel element spacer grid construction (Patent), 3:26399
Method and device for inserting a multitude of fuel rods into a fuel element frame, 3:26392
FUEL ELEMENTS/SUPPORTS
Nuclear reactor fuel element (Patent), 3:26395
FUEL ELEMENTS/TEMPERATURE DISTRIBUTION
Calculation of the temperature field in a fuel element with a rod core and a peeling sheath, 3:26404
FUEL FEEDING SYSTEMS/PLUGGING
Review and evaluation of failures, maintenance, and operability data for CO_2 Acceptor Plant mechanical equipment, 3:25640 (MIT-78-TR3)
FUEL GAS
See also INTERMEDIATE BTU GAS
LOW BTU GAS
FUEL GAS/CLEANING
CFCC Development Program. Monthly report, November 1977, 3:26142 (FE-2357-19)
FUEL GAS/DESULFURIZATION
Corrosion control in gas processing plants which remove CO_2 and H_2S (Monoethanolamine), 3:25768
FUEL GAS/PURIFICATION
Economics of carbon dioxide removal, 3:26019 (COO/2991-19)
Review and evaluation of failures, maintenance, and operability data for CO_2 Acceptor Plant mechanical equipment, 3:25640 (MIT-78-TR3)
FUEL LOADING
See REACTOR FUELING
FUEL MANAGEMENT/OPTIMIZATION
Optimal power profile fuel management, 3:26250
FUEL OILS
See also HEATING OILS
FUEL OILS/CHARGES
Annual summary of cost and quality of electric utility plant fuels, 1976, 3:25722 (TID-28133)
FUEL OILS/COMBUSTION
Coal-oil slurry combustion demonstration, Phase I. Monthly report, November 1977, 3:25714 (FE-2564-9)
Coal-oil slurry combustion demonstration, Phase I. Monthly report, December 1977, 3:25715 (FE-2564-10)
FUEL OILS/CONSUMPTION RATES
Annual summary of cost and quality of electric utility plant fuels, 1976, 3:25722 (TID-28133)
FUEL OILS/DESULFURIZATION
Advanced technology fuel cell program. Interim report, 3:26543 (EPRI-EM-576)
FUEL OILS/PARTIAL OXIDATION PROCESSES
Partial oxidation of fuel oil route to methanol production, 3:25966
FUEL OILS/REFORMER PROCESSES
Advanced technology fuel cell program. Interim report, 3:26543 (EPRI-EM-576)
FUEL OILS/STEAM REFORMER PROCESSES
Advanced technology fuel cell program. Interim report, 3:26543 (EPRI-EM-576)
FUEL PARTICLES
See also COATED FUEL PARTICLES
FUEL PARTICLES/CHEMICAL PREPARATION
Method of making nuclear fuel bodies (Patent), 3:25921
FUEL PARTICLES/FABRICATION
Properties and irradiation behavior of advanced oxide particle fuel (LMFBR, BWR, PWR), 3:26305
FUEL PARTICLES/PERFORMANCE TESTING
Properties and irradiation behavior of advanced oxide particle fuel (LMFBR, BWR, PWR), 3:26305
FUEL PELLETS/COMPRESSION
Space charge limited current flow between concentric spheres at potentials up to 15 MV, 3:27684

FUEL PELLETS/MELTDOWN
Experimental study of advanced fuel-pin failure phenomena (LMFBR), 3:26313
FUEL PELLETS/PERFORMANCE TESTING
Experimental study of advanced fuel-pin failure phenomena (LMFBR), 3:26313
FUEL PELLETS/SURFACE COATING
Plasma polymerization coating of D-T filled glass shells for laser fusion targets, 3:27682 (UCRL-80162)
FUEL PINS/CHEMICAL RADIATION EFFECTS
US-UK technical exchange breeder reactor fuels: fuel pin chemistry, 3:26282 (HEDL-6297)
FUEL PINS/CREEP
Creep behavior of mixed-carbide advanced nuclear fuel (LMFBR), 3:26635
FUEL PINS/MECHANICAL PROPERTIES
Fuel properties of advanced fuels (U,Pu)CN important for out-of-pile and in-pile kinetics (LMFBR), 3:26634
FUEL PINS/MEETINGS
Advanced LMFBR fuels, 3:26292
FUEL PINS/PERFORMANCE
Assumptions, constraints and methodology of ANL advanced fuels system studies (LMFBR), 3:26322
Development of LMFBR core designs using reference and advanced oxide fuel, 3:26321
Investigation of sodium-bonded carbide fuel assembly design (LMFBR), 3:26324
Irradiation performance analysis of UK fast reactor fuel (LMFBR), 3:26317
LIFE code system for analysis of oxide fuel pin thermal/structural behavior (LMFBR), 3:26320
Optimization system design studies of advanced carbide fuel (LMFBR), 3:26323
Progress in modeling carbide and nitride fuel performance in advanced LMFBRs, 3:26318
Some observations on oxygen and carbon potentials in U-Pu-O and U-Pu-C systems (LMFBR), 3:26599
FUEL PINS/PERFORMANCE TESTING
Analytical comparison of the irradiation behavior of fast reactor carbide and oxide fuel pins (LMFBR), 3:26319
Case for fuel redesign after in pile safety experiments: the "COMMANDO" tests (LMFBR), 3:26315
Chemical state of irradiated carbide fuel pins (LMFBR), 3:26641
CNEN program on advanced LMFBR fuels, 3:26299
Correlation between properties and irradiation behavior for carbide, carbonitride and nitride fuels (LMFBR), 3:26316
Design and performance of shroud tubes (LMFBR), 3:26325
Experience and future plan of fast reactor oxide fuels irradiation in Japan, 3:26301
French advanced fuels development program (LMFBR), 3:26296
French irradiation test experience for carbide fuels (LMFBR), 3:26309
German carbide irradiation test experience for fast reactors (LMFBR), 3:26308
GFEK experimental approach to carbide fuel element licensing (LMFBR), 3:26314
Irradiation behavior of sphere-pac carbide fuel (LMFBR), 3:26310
Japanese development program for advanced LMFBR fuels, 3:26297
Mechanical behavior of a fuel pin for fast reactors: effect of the fuel form and of the approach-to-power on the change of the fuel stack length under irradiation, 3:26302
Mixed-nitride fuel performance in EBR-II (LMFBR), 3:26306
UK irradiation experience relevant to advanced oxide fuel concepts for LMFBR's, 3:26300
UK irradiation experience relevant to advanced carbide fuel concepts for LMFBR's, 3:26307
US advanced LMFBR fuels development program, 3:26293
US experience in irradiation testing of advanced oxide fuels (LMFBR), 3:26303
FUEL PINS/PHYSICAL RADIATION EFFECTS
Design and performance of shroud tubes (LMFBR), 3:26325
French irradiation test experience for carbide fuels (LMFBR), 3:26309
German carbide irradiation test experience for fast reactors (LMFBR), 3:26308
Irradiation behavior of sphere-pac carbide fuel (LMFBR), 3:26310
Irradiation experiments of uranium carbide, carbonitride, and nitride fuels in JAERI (LMFBR), 3:26311
FUEL PINS/PLANNING
Development of advanced fuels in Switzerland (LMFBR), 3:26298
UK strategy and programmes for advanced LMFBR fuels, 3:26294
FUEL PINS/REACTOR SAFETY
Advanced fuels safety comparisons (LMFBR), 3:26477
FUEL PINS/RESEARCH PROGRAMS
CNEN program on advanced LMFBR fuels, 3:26299
UK irradiation experience relevant to advanced oxide fuel concepts for LMFBR's, 3:26300
FUEL PINS/SPECIFICATIONS
Assumptions, constraints and methodology of ANL advanced fuels system studies (LMFBR), 3:26322
Development of LMFBR core designs using reference and advanced oxide fuel, 3:26321
Optimization system design studies of advanced carbide fuel (LMFBR), 3:26323
FUEL PINS/TEST FACILITIES
Japanese development program for advanced LMFBR fuels, 3:26297
FUEL PINS/THERMODYNAMIC PROPERTIES
Thermophysical properties of liquid uranium carbide (LMFBR), 3:26633
FUEL POOLS/DESIGN
Design report and safety evaluation for high density fuel storage system. Licensing topical report, 3:26208 (NEDO-24076)
FUEL RODS/FABRICATION
Procedure for drying humidity-containing bodies (Patent), 3:26393
FUEL RODS/PERFORMANCE TESTING
Response of unirradiated and irradiated PWR fuel rods tested under power-cooling-mismatch conditions, 3:26443 (TREE-NUREG-1196)
FUEL SLURRIES/HYDRODYNAMICS
Three-phase flow characteristics of cylindrical vessels, 3:25662 (ORNL/MIT-257)
FUEL SLURRIES/STABILITY
Coal-oil slurry combustion demonstration, Phase I. Monthly report, November 1977, 3:25714 (FE-2564-9)
Coal-oil slurry combustion demonstration, Phase I. Monthly report, December 1977, 3:25715 (FE-2564-10)
FUEL SLURRIES/STORAGE
Coal-oil slurry combustion demonstration, Phase I. Monthly report, November 1977, 3:25714 (FE-2564-9)
Coal-oil slurry combustion demonstration, Phase I. Monthly report, December 1977, 3:25715 (FE-2564-10)
FUEL SYSTEMS
See also FUEL FEEDING SYSTEMS
FUEL SYSTEMS/SIMULATION
Testing and evaluation of MHD materials and substructures. Quarterly technical progress report, January-March 1977, 3:26538 (FE-2246-3(Rev.A))
FUEL-CLADDING INTERACTIONS
Chemical thermodynamics of the system Cs-U-Zr-H-I-O in the LWR fuel-clad gap, 3:26211 (ORNL/TM-6130)
FUMAROLES/MINERALOGY
Incrustations and fumarolic condensates at Kilauea volcano, Hawaii: field, drill-hole and laboratory observations, 3:26123
FUMAROLIC FLUIDS/CHEMICAL COMPOSITION
Incrustations and fumarolic condensates at Kilauea volcano, Hawaii: field, drill-hole and laboratory observations, 3:26123
FUMES
See AEROSOLS
FUNCTIONAL ANALYSIS
Nonuniqueness of best approximating complex rational functions, 3:27714
FUNCTIONAL ANALYSIS/NONLINEAR PROBLEMS
Some recent results in bifurcation theory, 3:27421
FUNCTIONS
See also GREEN FUNCTION
FUNCTIONS/SERIES EXPANSION
Geometric overconvergence of rational functions in unbounded domains, 3:27716
FUNDAMENTAL PARTICLES
See ELEMENTARY PARTICLES
FUNGI
See also NEUROSPORA
YEASTS
FUNGI/BIOLOGICAL INDICATORS
Literature survey of bacterial, fungal, and Drosophila assay systems used in the evaluation of selected chemical compounds for mutagenic activity, 3:26994 (ORNL/EMIC-9)
FUNGI/LIFE CYCLE
Ultrastructure of the life cycle of rust fungi, 3:26979 (CONF-770504-)
FUNGI/ULTRASTRUCTURAL CHANGES
Ultrastructure of the life cycle of rust fungi, 3:26979 (CONF-770504-)
FURNACES/BURNERS
Brookhaven National Laboratory Burner-Boiler/Furnace Efficiency Test Project. Hydronic equipment findings report reference manual, 3:26777 (BNL-50644)
FURNACES/CORROSION
Thermodynamic phase stability diagrams for the analysis of corrosion reactions in coal gasification/combustion atmospheres. Interim report, 3:25626 (EPRI-FP-539)
FURNACES/REMOTE VIEWING EQUIPMENT
Development and use of a TV system for viewing flames, 3:26782
FUSION REACTORS
See THERMONUCLEAR REACTORS

G

GADOLINIUM/HYPERFINE STRUCTURE
Self-consistent screening of a positive muon in a spin-polarized electron gas, 3:26604
GADOLINIUM/INTERSTITIALS
Self-consistent screening of a positive muon in a spin-polarized electron gas, 3:26604
GADOLINIUM 154 TARGET/ALPHA REACTIONS
E2 and E4 reduced matrix elements of $^{154\ 156\ 158\ 160}$Gd and $^{176\ 178\ 180}$Hf, 3:27373
GADOLINIUM 156/ENERGY-LEVEL TRANSITIONS
Properties of the second K/sup π/+ band in ^{156}Gd, 3:27371
GADOLINIUM 156 TARGET/ALPHA REACTIONS
E2 and E4 reduced matrix elements of $^{154\ 156\ 158\ 160}$Gd and $^{176\ 178\ 180}$Hf, 3:27373
GADOLINIUM 158 TARGET/ALPHA REACTIONS
E2 and E4 reduced matrix elements of $^{154\ 156\ 158\ 160}$Gd and $^{176\ 178\ 180}$Hf, 3:27373
GADOLINIUM 160 TARGET/ALPHA REACTIONS
E2 and E4 reduced matrix elements of $^{154\ 156\ 158\ 160}$Gd and $^{176\ 178\ 180}$Hf, 3:27373
GADOLINIUM COMPOUNDS/KNIGHT SHIFT
Systematics in the Knight shift of rare-earth monopnictides, 3:26600
GALLIUM/ION EXCHANGE
Cation exchange of 53 elements in nitric acid, 3:26665 (LA-7083)
GALLIUM/SUPERCONDUCTIVITY
Oscillations of properties of thin superconducting films with varying coating thickness, 3:26624
GALLIUM ARSENIDE SOLAR CELLS/CALIBRATION
Comparative performance of silicon and gallium arsenide solar cells on a high altitude sounding rocket, 3:25998
GALLIUM ARSENIDE SOLAR CELLS/FEASIBILITY STUDIES
GaAs solar cells for very high concentrations, 3:26000
GALLIUM ARSENIDE SOLAR CELLS/SOLAR CONCENTRATORS
GaAs solar cells for very high concentrations, 3:26000
GALLIUM ARSENIDES/AUGER EFFECT
Theory of valence-band Auger spectra: GaAs(110), 3:26651
GAMMA DOSIMETRY/THERMOLUMINESCENT DOSEMETERS
Gamma-ray dosimetry errors with TLDs, 3:26827 (UCRL-80183)
Photon and beta response of a new thermoluminescent dosimeter badge, 3:26824 (LA-UR-77-3001)
GAMMA LOGGING/DATA ANALYSIS
Manual on gamma logging in search and exploration of uranium deposts, 3:25913
GAMMA LOGGING/PERFORMANCE
Use of borehole geophysical methods in determining in situ bulk densities and water contents in unconsolidated materials. Final report, 3:26844 (AD-A-046114)
GAMMA-GAMMA LOGGING/PERFORMANCE
Use of borehole geophysical methods in determining in situ bulk densities and water contents in unconsolidated materials. Final report, 3:26844 (AD-A-046114)
GAS ANALYSIS/ON-LINE SYSTEMS
Flash pyrolysis coal liquefaction process development. Monthly report, July 1977, 3:25654 (FE-2244-15)
GAS CHROMATOGRAPHY/DATA ACQUISITION SYSTEMS
Application of a GC/MS data system at Rocky Flats (Analysis of organic compounds), 3:26839 (RFP-2558)
GAS COMPRESSORS
Ultra low-temperature LNG compressors, 3:25889
GAS COMPRESSORS/MAINTENANCE
Review and evaluation of failures, maintenance, and operability data for CO_2 Acceptor Plant mechanical equipment, 3:25640 (MIT-78-TR3)
GAS COMPRESSORS/PERFORMANCE
Contribution to calculate the performance of multistage axial-flow compressors, 3:26567
GAS COMPRESSORS/RECOMMENDATIONS
Review and evaluation of failures, maintenance, and operability data for CO_2 Acceptor Plant mechanical equipment, 3:25640 (MIT-78-TR3)
GAS COMPRESSORS/TORQUE
Relaxation of variable torque in the shafting for LPG compressors, 3:25834
GAS CONDENSATE FIELDS/PRODUCTIVITY
Gas-condensate fields of the Taranaki basin, New Zealand, 3:25825
GAS COOLANTS
See GASES
GAS COOLED FAST BREEDER REACTORS
See GCFR TYPE REACTORS
GAS COOLED REACTORS
See also AGR TYPE REACTORS
GCFR TYPE REACTORS
HTGR TYPE REACTORS
GAS COOLED REACTORS/COOLANTS
Improvements in or relating to power plant coolant (Patent, N_2O_4), 3:26361
GAS COOLED REACTORS/EVAPORATORS
Experimental investigation of heat transfer in a once-through regenerator-evaporator with a chemically reacting coolant, 3:26383
GAS COOLED REACTORS/FISSION POISONS
Material for shutting down gas cooled nuclear reactors (Patent), 3:26407
GAS FUELED REACTORS
Space propulsion system for terrestrial electricity, 3:26426
GAS LASERS
See also CARBON DIOXIDE LASERS
CARBON MONOXIDE LASERS
HELIUM-NEON LASERS
GAS LASERS/DESIGN
Annular iodine laser facility. Interim report, 3:26717 (AD-A-042282)
Closed-cycle rare-gas electrical-discharge laser. Final report, 1 June 1973-30 September 1976, 3:26715 (AD-A-042233)
Hypersonic gas laser (Patent), 3:26745
Laser as a means of transferring a standard frequency into the submillimeter range (HCN), 3:26757
Performance characteristic of discharge excited excimer lasers, 3:26737 (LA-UR-77-328)
GAS LASERS/FAR ULTRAVIOLET RADIATION
Concerning the problem of lasers for the far ultraviolet $\lambda \sim 500$-700 A, 3:26749
GAS LASERS/IODINE
Iodine laser. Master's thesis, 3:26718 (AD-A-042289)
GAS LASERS/MODE LOCKING
Injection-locked, narrow-band KrF discharge laser using an unstable resonator cavity, 3:26743
GAS LASERS/NOZZLES
Free expansion nozzle for gas dynamic lasers, 3:26753
GAS LASERS/PERFORMANCE
Annular iodine laser facility. Interim report, 3:26717 (AD-A-042282)
Performance characteristic of discharge excited excimer lasers, 3:26737 (LA-UR-77-328)
GAS LASERS/RESEARCH PROGRAMS
Copper halide laser research. Final report, 3:26723 (AD-A-042484)
Metal vapor visible laser kinetics program. Final technical report, 3:26716 (AD-A-042271)
Reactor and advanced heat transfer technology, 3:26705 (LA-6807-PR)
GAS LASERS/SUPERSONIC FLOW
Experimental study of an electrical discharge laser with supersonic gas flow in a magnetic field, 3:26744
GAS SPILLS/FIRE HAZARDS
Controlling the hazards from LNG spills on ground LNG fire fighting methods, 3:25842
GAS TURBINES/COMBUSTORS
Development of high temperature turbine subsystem technology to a "technology readiness status": Phase I. Quarterly report, January-March 1977. Preliminary draft, 3:26141 (FE-1806-20)
GAS TURBINES/DESIGN
Ceramic technology readiness program. Third monthly technical progress report, November 28, 1977-January 1, 1978, 3:26144 (FE/2664-3)
Kawasaki PU200 gas turbine power generator, 3:26180
GAS TURBINES/EFFICIENCY
Effect of the radial gap on the efficiency of axial unshrouded turbine stages, 3:26163
GAS TURBINES/MATERIALS
Ceramic technology readiness program. Third monthly technical progress report, November 28, 1977-January 1, 1978, 3:26144 (FE/2664-3)
CFCC Development Program. Monthly report, November 1977, 3:26142 (FE-2357-19)
GAS TURBINES/MATERIALS TESTING
CFCC Development Program. Monthly report, November 1977, 3:26142 (FE-2357-19)
GAS TURBINES/RESEARCH PROGRAMS
Closed gas turbine heater program. Second quarterly technical progress report, July 4, 1977-October 2, 1977, 3:26149 (TID-28200)
GASEOUS WASTES
See also EXHAUST GASES
FLUE GAS
GASEOUS WASTES/GAS ANALYSIS
Environmental assessment of the HYGAS Process. Project No. 9025 monthly progress report, August 1-August 31, 1977, 3:25637 (FE-2433-18)

GASES
See also AIR
COAL GAS
COSMIC GASES
NATURAL GAS
REFINERY GASES
GASES/DIFFUSION
Transport of liquids and gases through coatings, 3:26689
GASES/QUANTITATIVE CHEMICAL ANALYSIS
Selective single atom detection in a 10^{19} atom background, 3:27062
GASES/STORAGE
Bush dome model: computing movement of injected crude helium. Software, 3:25882 (PB-269450)
GASKETS/SERVICE LIFE
Degradation of EMP hardening devices, 3:26841 (SAND-77-0841)
GASOLINE/ANTIKNOCK RATINGS
Research and development of rapid hydrogenation for coal conversion to synthetic motor fuels (riser cracking of coal). Second quarter report, July 1-September 30, 1977, 3:25656 (FE-2307-25)
GASOLINE/CHEMICAL COMPOSITION
Research and development of rapid hydrogenation for coal conversion to synthetic motor fuels (riser cracking of coal). Second quarter report, July 1-September 30, 1977, 3:25656 (FE-2307-25)
GASOLINE/PRODUCTION
Effect of catalytic cracking method in product yields, 3:25774
GASOLINE/YIELDS
Effect of catalytic cracking method in product yields, 3:25774
GAUGE INVARIANCE/SYMMETRY BREAKING
Broken gauge and scale invariance, 3:27253
Natural stepwise breaking of gauge and discrete symmetries, 3:27151
GCFR TYPE REACTORS
Energy from nuclear reactors. Pt. 7. The gas breeder has some advantages: thorium as a fuel, 3:26290
GE STANDARD REACTOR
(Prior to 1975, BWR/6 TYPE REACTORS was used.)
GE tackles the nuclear island, 3:26217
GENERAL ELECTRIC STANDARD REACTOR
See GE STANDARD REACTOR
GENERATORS (ELECTRIC)
See ELECTRIC GENERATORS
GENERATORS (STEAM)
See STEAM GENERATORS
GENES/TEMPERATURE EFFECTS
Effects of high temperature on infections of E. coli B by bacteriophage T4D and its mutant in gene regA, 3:26976 (UR-3490/LCP-2)
GENETIC MAPPING
Yeast mitochondrial DNA specifies tRNA for 19 amino acids. Deletion mapping of the tRNA genes, 3:26950
GENETICS
Studies on mechanisms of mutation, recombination, and gene action in neurospora. Final report, 3:26968 (SRO-735-5)
GEOLOGIC DEPOSITS
See also NATURAL GAS DEPOSITS
OIL SAND DEPOSITS
OIL SHALE DEPOSITS
SALT DEPOSITS
URANIUM DEPOSITS
GEOLOGIC DEPOSITS/CHEMICAL COMPOSITION
Geochemical dispersion at the Mother Lode Mine near Kennicott, Alaska, 3:27015 (LA-6987-MS)
GEOLOGIC STRATA/PERMEABILITY
Numerical method of determination of hydrodynamic conductibility of a nonhomogeneous oil-bearing stratum, 3:25750
GEOLOGY
See also GEOLOGIC STRATA
GEOLOGY/MEETINGS
Exploration frontiers of the central and southern Rockies, 3:25729
GEOPRESSURED SYSTEMS/NATURAL GAS
Natural gas content of geopressured aquifers, 3:25826 (CONF-771153-1)
GEOPRESSURED SYSTEMS/NATURAL GAS DEPOSITS
Natural gas content of geopressured aquifers, 3:25826 (CONF-771153-1)
GEOTHERMAL ENERGY/ENERGY SOURCE DEVELOPMENT
Report on the development of geothermal energy, 3:26081 (NP-23047)
GEOTHERMAL ENERGY/USES
Report on the development of geothermal energy, 3:26081 (NP-23047)
GEOTHERMAL EXPLORATION/SEISMIC SURVEYS
Seismological methods and the search for geothermal resources, 3:26092
GEOTHERMAL FIELDS/GRAVITY SURVEYS
Preliminary report of study on the gravimetric monitoring at the Takinoue geothermal area, Iwate Prefecture. Study on the geothermal system of geothermal area: the 4th report, 3:26095
GEOTHERMAL FLUIDS
See also FUMAROLIC FLUIDS
GEOTHERMAL FLUIDS/CHEMICAL COMPOSITION
Geochemistry of the Hawaii geothermal well, HGP-A (abstract), 3:26100
GEOTHERMAL WELLS/DIRECTIONAL DRILLING
Multiple-completion geothermal energy production systems (Patent), 3:26105
GEOTHERMAL WELLS/HEAT EXTRACTION
Multiple-completion geothermal energy production systems (Patent), 3:26105
GERM CELLS/CELL PROLIFERATION
Procedures for the detection of unscheduled DNA synthesis in the germ cells of mole mice exposed in vivo to chemical mutagens (^{3}H-dt tracer study), 3:26996 (TID-28142)
GERMAN FEDERAL REPUBLIC/COAL INDUSTRY
Medium-term aspects of a coal revival: two case studies, 3:25721 (IIASA-CP-77-5)
GERMAN FEDERAL REPUBLIC/DISTRICT HEATING
District heating as a task for government and economy. Existing networks to be extended systematically: special responsibilities for communities, 3:26508
GERMAN FEDERAL REPUBLIC/ELECTRIC POWER INDUSTRY
Growth and adaptation processes in the power industry of the Federal Republic of Germany. A simulation model (Book, in German), 3:26526
GERMAN FEDERAL REPUBLIC/ENERGY DEMAND
Growth and adaptation processes in the power industry of the Federal Republic of Germany. A simulation model (Book, in German), 3:26526
Medium-term aspects of a coal revival: two case studies, 3:25721 (IIASA-CP-77-5)
GERMAN FEDERAL REPUBLIC/ENERGY POLICY
Governmental promotion of technologies not harmful to the environment (Book, in German), 3:26518
GERMAN FEDERAL REPUBLIC/ENERGY SUPPLIES
Medium-term aspects of a coal revival: two case studies, 3:25721 (IIASA-CP-77-5)
GERMAN FEDERAL REPUBLIC/GEOTHERMAL RESOURCES
Geothermal energy from salt domes, 3:26082 (NP-23044)
GERMAN FEDERAL REPUBLIC/HEAT FLOW
Temperature/depth distribution in the Federal Republic of Germany, 3:26087 (NP-23046)
GERMAN FEDERAL REPUBLIC/NUCLEAR POWER
Energy research program of the Federal Republic of Germany, 3:26341
GERMAN FEDERAL REPUBLIC/NUCLEAR POWER PLANTS
Nuclear power. Analyses and prognoses, 3:26337
GERMAN FEDERAL REPUBLIC/POLLUTION REGULATIONS
Licensing procedures according to the Federal Act for Protection Against Nuisances. Text of the 9th implementation ordinance with explanations and supplementing regulations, 3:26892
New Federal Act for protection against nuisances (BImSchV), 3:26891
GERMAN FEDERAL REPUBLIC/POWER
How Germany came to have nuclear energy: a stop half-way, 3:26336
GERMANIUM/CHARGED-PARTICLE TRANSPORT
A boltzmann transport code for ion penetration in matter. Memorandum report, 3:27399 (AD-A-043502)
GERMANIUM/ELECTRONIC STRUCTURE
Strain-confined electron-hole liquid in germanium, 3:26646
GERMANIUM/ION EXCHANGE
Cation exchange of 53 elements in nitric acid, 3:26665 (LA-7083)
GERMANIUM 67/ENERGY LEVELS
New isotopes of interest to explosive nucleosynthesis (Half-lives, branching ratios, J, π), 3:27355 (ANL-77-60)
GERMANIUM 67/ISOMERIC TRANSITIONS
New isotopes of interest to explosive nucleosynthesis (Half-lives, branching ratios, J, π), 3:27355 (ANL-77-60)
GERMANIUM 67/MASS DEFECT
New isotopes of interest to explosive nucleosynthesis (Half-lives, branching ratios, J, π), 3:27355 (ANL-77-60)
GERMANIUM 70/HIGH SPIN STATES
High-spin states in ^{70}Ge, 3:27358
GERMANIUM ALLOYS/SUPERCONDUCTIVITY
Estimate of density-of-states changes with disorder in A-15 superconductors, 3:26602
GERMANIUM ARSENIDES/ELECTRONIC STRUCTURE
Raman scattering from hybridized electronic levels in uniaxially stressed Ge(As), 3:26657

GERMANY (FEDERAL REPUBLIC)
See GERMAN FEDERAL REPUBLIC
GEYSERS GEOTHERMAL FIELD/HEAT FLOW
Heat flow in a geothermally active area: the Geysers, California, 3:26099
GIANT CELLS
See TUMOR CELLS
GLACIERS/GEOTHERMAL HEATING
Explanation of Joekulhlaups from Grimsvoetn, Vatnajoekull, Iceland, 3:26090
GLASS INDUSTRY/ENERGY CONSERVATION
Energy efficiency improvement target for SIC 32: stone, clay, and glass products. Volume 1. Draft report. Research report, 3:26562 (PB-269880)
Energy efficiency improvement target for SIC 32: stone, clay, and glass products. Volume 2. Draft report. Appendices. Research report, 3:26563 (PB-269881)
Energy efficiency improvement target for SIC 32: stone, clay, and glass products. Volume 3. Draft report. Appendices. Research report, 3:26564 (PB-269882)
Energy efficiency improvement target for SIC 32: stone, clay, and glass products. Volume 4. Final report. Research report, 3:26565 (PB-269883)
GLASS INDUSTRY/ENVIRONMENTAL IMPACTS
Source assessment: pressed and blown glass manufacturing plants. Final task report Sep 75-Jan 77, 3:26882 (PB-273788)
GLAZING MATERIALS/SPECTRALLY SELECTIVE SURFACES
Wavelength-selective surfaces for solar energy utilization, 3:26070
GLIOBLASTOMAS
See NEOPLASMS
GLUCOSE/METABOLISM
Investigation of ^{18}F-2-deoxyglucose for the measure of myocardial glucose metabolism, 3:26993 (UCLA-12-1142)
GLUON MODEL
(Describes the interaction of a neutral massive vector field with a massive spinor field.)
GLUON MODEL/COUPLING
More freedom now: an explanation of local duality and other mysteries, 3:27164
GLUON MODEL/DECAY
Semiclassical infrared emission processes in the $(\text{phi}^4)_4$ theory, 3:27152
GLUON MODEL/INFRARED DIVERGENCES
Nonperturbative approach to infrared behavior for $(\text{phi}^3)_6$ theory and a mechanism of confinement, 3:27155
GLUON MODEL/JET MODEL
Jet structure in e^+e^- annihilation as a test of quantum chromodynamics and the quark-confining string, 3:27176
GLUON MODEL/PSI RESONANCES
Gauge fields and strong interactions (Lectures), 3:27212
GLYCOLS/SORPTIVE PROPERTIES
Absorption of ammonia with organic solvents, 3:25969
GOLD/INTERSTITIALS
Direct observation of self-interstitial-type defects in metals through combined single-double alignment channeling backscattering, 3:26627
GOLD/ION EXCHANGE
Cation exchange of 53 elements in nitric acid, 3:26665 (LA-7083)
GOLD/PHYSICAL RADIATION EFFECTS
Direct observation of self-interstitial-type defects in metals through combined single-double alignment channeling backscattering, 3:26627
Radiation-annealing effects in energetic displacement cascades, 3:26628
GOLD 197/GIANT RESONANCE
Investigation of giant multipole resonances in medium and heavy nuclei by inelastic electron scattering. Final technical report, 15 October 1974-31 October 1976, 3:27356 (AD-A-042298)
GOLD 197 TARGET/ELECTRON REACTIONS
Investigation of giant multipole resonances in medium and heavy nuclei by inelastic electron scattering. Final technical report, 15 October 1974-31 October 1976, 3:27356 (AD-A-042298)
GOLD 197 TARGET/KRYPTON 86 REACTIONS
Pre-equilibrium α emission in reactions of 724-MeV ^{86}Kr with Au: A coincidence study of direct and evaporation mechanisms, 3:27379
GOLD 197 TARGET/NEUTRON REACTIONS
Cross sections for (n,2n) and (n,3n) reactions above 14 MeV, 3:27353
GOLGI APPARATUS
See ORGANOIDS
GRANITES/HYDRAULIC FRACTURING
Effect of principal stress magnitudes on hydrofracturing orientation. Final report (Montello granite), 3:27014 (UCRL-13795)
GRANITES/STRESS ANALYSIS
Effect of principal stress magnitudes on hydrofracturing orientation. Final report (Montello granite), 3:27014 (UCRL-13795)
GRANODIORITES/ROCK-FLUID INTERACTIONS
Reaction of granodiorite with water at 300°C and 1/3 kb in a circulation system (abstract), 3:26121
GRAPHITE MODERATED REACTORS
See also AGR TYPE REACTORS
HTGR TYPE REACTORS
GRAPHITE MODERATED REACTORS/BREEDING RATIO
Absolute fission-rate distributions in lithium and hybrid fusion blanket assemblies, (2). Analysis and evaluation, 3:27622
GRAPHITE MODERATED REACTORS/REACTOR CORES
Reactor core consisting of a number of interspersed groups of identical columns (Patent), 3:26266
GRAVITATION/RESEARCH PROGRAMS
Progress report for a research program in theoretical high-energy physics, 3:27146 (COO-3130TA-340)
GRAVITATIONAL WAVES
Gravitational waves (Gravitational shock waves and connection with electromagnetic shock waves), 3:27413
GREASES/PERFORMANCE
Deuterated fluids: deuterated synthetic hydrocarbon fluid and grease. Final report, 3:26690 (AD-A-042618)
GREAT BRITAIN
See UNITED KINGDOM
GREEN FUNCTION
Some functional inequalities, with application to Green's function, 3:27409
GREIFSWALD-2 REACTOR/PRIMARY COOLANT CIRCUITS
Effects on the activity level in the primary circuit water coolant of pressurized water reactors by continuous purification of partial streams, 3:26231
GROUND WATER/WATER POLLUTION
Effects of underground coal gasification on ground-water quality, 3:25644 (UCRL-80145)
GRUENEISEN CONSTANT/EQUATIONS
Approximate method for determining the influence of water and porosity on the Gruneisen gamma, 3:26647 (UCRL-76010)
GRUENEISEN CONSTANT/NUMERICAL SOLUTION
Approximate method for determining the influence of water and porosity on the Gruneisen gamma, 3:26647 (UCRL-76010)
GUIDING-CENTER APPROXIMATION/CORRECTIONS
Extensions of guiding center motion to higher order, 3:27508
GULF OF MEXICO/NATURAL GAS DEPOSITS
Natural gas content of geopressured aquifers, 3:25826 (CONF-771153-1)

H

HADRON REACTIONS/REVIEWS
Review of hadron-nucleus interactions at high energy, 3:27226 (COO-3069-556)
HADRON-HADRON INTERACTIONS
See also NUCLEON-NUCLEON INTERACTIONS
HADRON-HADRON INTERACTIONS/COLOR MODEL
Currents, quarks, and gluons, 3:27162
HADRON-HADRON INTERACTIONS/EXCLUSIVE INTERACTIONS
Large transverse momentum phenomena, 3:27205 (SLAC-PUB-2009)
HADRON-HADRON INTERACTIONS/GLUON MODEL
Currents, quarks, and gluons, 3:27162
Gauge fields and strong interactions (Lectures), 3:27212
HADRON-HADRON INTERACTIONS/INCLUSIVE INTERACTIONS
High transverse momentum hadron-hadron collisions, 3:27214
Large transverse momentum phenomena, 3:27205 (SLAC-PUB-2009)
HADRON-HADRON INTERACTIONS/QUARK MODEL
Gauge fields and strong interactions (Lectures), 3:27212
Retention of quantum numbers by quark and multiquark jets, 3:27159
HADRON-HADRON INTERACTIONS/SCATTERING AMPLITUDES
Disentangling the scattering matrix when there is a dominant reaction mechanism, 3:27208
HADRON-HADRON INTERACTIONS/STRING MODELS
Strings, vortices, and gauge fields, 3:27211
HADRON-HADRON INTERACTIONS/TOTAL CROSS SECTIONS
Simple interpretation of the Reggeon cutting rules, 3:27210

HADRON-HADRON INTERACTIONS/TRANSVERSE MOMENTUM
Large transverse momentum phenomena, 3:27205 (SLAC-PUB-2009)
HADRON-HADRON INTERACTIONS/YANG-MILLS THEORY
Gauge fields and strong interactions (Lectures), 3:27212
HADRONIC ATOMS
(Atoms with a hadron such as an antiproton or a sigma-minus particle bound in atomic orbits.)
HADRONIC ATOMS/ANTIPROTONS
Light antiprotonic atoms and quasinuclear mesons, 3:27236
HADRONIC ATOMS/X-RAY SPECTRA
Strong interaction and mass measurements using antiprotonic atoms, 3:27130
HADRONS
See also BARYONS
MESONS
RESONANCE PARTICLES
HADRONS/DECAY
Quantum mechanics in particle physics, 3:27202
Search for heavy particles, 3:27184 (SLAC-PUB-1891)
HADRONS/ELECTROPRODUCTION
Gauge fields and strong interactions (Lectures), 3:27212
Production of new particles and muon-electron events in e^+-e^- annihilation at spear, 3:27100 (SLAC-PUB-1737)
HADRONS/LEPTON NUMBER
Search for heavy particles, 3:27184 (SLAC-PUB-1891)
HADRONS/MASS SPECTRA
Impact of quantum electrodynamics, 3:27255 (SLAC-PUB-1699)
Nuclear collisions at very high energy, 3:27147 (LBL-6597)
Quantum mechanics in particle physics, 3:27202
HADRONS/MULTIPLE PRODUCTION
Nonresonant multibody production by $e^+ e^-$ annihilation (Jet-like structure, angular distribution, review cross sections), 3:27101 (SLAC-PUB-1745)
HADRONS/PARTICLE MODELS
Quark-quark interactions at the p anti p Collider, 3:27207 (TID-28062)
HADRONS/PARTICLE PRODUCTION
Quark-quark interactions at the p anti p Collider, 3:27207 (TID-28062)
HADRONS/PARTICLE PROPERTIES
Search for heavy particles, 3:27184 (SLAC-PUB-1891)
HADRONS/PARTICLE STRUCTURE
Quark confinement (Lectures), 3:27206 (SLAC-PUB-2020)
HADRONS/QUANTUM FIELD THEORY
Hadrons (usual and newly discovered) in gauge theories a dream, 3:27213
HADRONS/QUARK MODEL
Quark confinement (Lectures), 3:27206 (SLAC-PUB-2020)
HADRONS/STRING MODELS
Strings, vortices, and gauge fields, 3:27211
HAFNIUM/ION EXCHANGE
Cation exchange of 53 elements in nitric acid, 3:26665 (LA-7083)
HAFNIUM 176/YRAST STATES
Description of yrast traps in ^{176}Hf, 3:27368
HAFNIUM 176 TARGET/ALPHA REACTIONS
E2 and E4 reduced matrix elements of $^{154\ 156\ 158\ 160}$Gd and $^{176\ 178\ 180}$Hf, 3:27373
HAFNIUM 178 TARGET/ALPHA REACTIONS
E2 and E4 reduced matrix elements of $^{154\ 156\ 158\ 160}$Gd and $^{176\ 178\ 180}$Hf, 3:27373
HAFNIUM 180 TARGET/ALPHA REACTIONS
E2 and E4 reduced matrix elements of $^{154\ 156\ 158\ 160}$Gd and $^{176\ 178\ 180}$Hf, 3:27373
HAFNIUM COMPOUNDS/MAGNETIC RESONANCE
Optical and zero field magnetic resonance spectroscopy of inorganic molecular solids. Final report, 1 June 1975-31 May 1977, 3:26645 (AD-A-043340)
HAFNIUM COMPOUNDS/OPTICAL PROPERTIES
Optical and zero field magnetic resonance spectroscopy of inorganic molecular solids. Final report, 1 June 1975-31 May 1977, 3:26645 (AD-A-043340)
HALL GENERATORS
See MHD GENERATORS
HALOGENATED ALIPHATIC HYDROCARBONS/DISSOCIATION
Multiphoton dissociation products from halogenated hydrocarbons, 3:27046
HAMM-UENTROP REACTOR/REACTOR LICENSING
Recommendations of the Reactor Safety Commission during its 121st meeting on February 16th, 1977. Kernkraftwerk Hamm (KKH). Site and safety concept, 3:26243
HANFORD ATOMIC PRODUCTS OPERATION
See HAPO
HANFORD RESERVATION/ATMOSPHERIC PRECIPITATIONS
Abiotic components, 3:25945 (PNL-2253)
HANFORD RESERVATION/BIRDS
Biotic components, 3:25946 (PNL-2253)
HANFORD RESERVATION/CLIMATES
Abiotic components, 3:25945 (PNL-2253)
HANFORD RESERVATION/ECOLOGY
Abiotic components, 3:25945 (PNL-2253)
Ecology of the 200 Area plateau waste management environs: a status report, 3:25943 (PNL-2253)
Ecology of Hanford 200 Area and 1976 radionuclide inventory, 3:25944 (PNL-2253)
HANFORD RESERVATION/METEOROLOGY
Abiotic components, 3:25945 (PNL-2253)
HANFORD RESERVATION/MINERAL CYCLING
Energy flow and mineral cycling mechanisms, 3:25947 (PNL-2253)
HANFORD RESERVATION/PLANTS
Biotic components, 3:25946 (PNL-2253)
HANFORD RESERVATION/RADIATION MONITORING
Radionuclide transport (Hanford terrestrial ecosystems), 3:25948 (PNL-2253)
HANFORD RESERVATION/RADIONUCLIDE MIGRATION
Ecology of the 200 Area plateau waste management environs: a status report, 3:25943 (PNL-2253)
HANFORD RESERVATION/SOILS
Abiotic components, 3:25945 (PNL-2253)
HANFORD RESERVATION/TERRESTRIAL ECOSYSTEMS
Energy flow and mineral cycling mechanisms, 3:25947 (PNL-2253)
Impact of radioactive waste management operations, 3:25949 (PNL-2253)
Radionuclide transport (Hanford terrestrial ecosystems), 3:25948 (PNL-2253)
HAPO
(Hanford Atomic Products Operation.)
HAPO/RADIATION MONITORING
Hanford critical radiation dosimeter, 3:26826 (PNL-2276)
HAPO/RADIOACTIVE WASTE MANAGEMENT
Applications to waste management operations (Terrestrial ecosystems), 3:25951 (PNL-2253)
Ecology of the 200 Area plateau waste management environs: a status report, 3:25943 (PNL-2253)
Ecology of Hanford 200 Area and 1976 radionuclide inventory, 3:25944 (PNL-2253)
Impact of radioactive waste management operations, 3:25949 (PNL-2253)
HAPO/RESEARCH PROGRAMS
Ecology of the 200 Area plateau waste management environs: a status report, 3:25943 (PNL-2253)
HARBORS/BIBLIOGRAPHIES
Supertankers and superports (citations from the NTIS data base). Report for 1964-July 1977 (Construction; operation), 3:25807 (NTIS/PS-77/0700)
Supertankers and superports (citations from the Engineering Index data base). Report for 1970-July 1977, 3:25808 (NTIS/PS-77/0701)
HAWAII/FUMAROLES
Incrustations and fumarolic condensates at Kilauea volcano, Hawaii: field, drill-hole and laboratory observations, 3:26123
HAWAII/GEOTHERMAL EXPLORATION
Evaluation of geophysical techniques for geothermal exploration on an active basaltic volcano (abstract), 3:26093
HAWAII/VOLCANOES
Incrustations and fumarolic condensates at Kilauea volcano, Hawaii: field, drill-hole and laboratory observations, 3:26123
HAZARDOUS MATERIALS/WASTE DISPOSAL
Disposal of hazardous wastes, manual on hazardous substances in special wastes, 3:26572 (PB-270591-T/SL)
H-COAL PROCESS/EBULLATED BED
Study of ebullated bed fluid dynamics for H-coal. Monthly progress report No. 4, December 1-December 31, 1977, 3:25659 (FE-2588-4)
H-COAL PROCESS/PILOT PLANTS
H-Coal Pilot Plant. Phase II. Construction. Phase III. Operation. Monthly report, December 1977, 3:25655 (FE-2260-16)
H-COAL PROCESS/RECOMMENDATIONS
Assessment of technology for the liquefaction of coal: summary, 3:25661 (FE/1216-2)
HEAT DISTRIBUTION SYSTEMS/DESIGN
Main means of improving designs of heating networks, 3:26548
Problems of improving the methods of designing heat supply systems, 3:26545
HEAT DISTRIBUTION SYSTEMS/HYDRAULICS
Hydraulic design of a branched heating network, employing an electronic digital computer, 3:26547
HEAT DISTRIBUTION SYSTEMS/PLANNING
District heating as a task for government and economy. Existing networks to be extended systematically: special responsibilities for communities, 3:26508

HEAT DISTRIBUTION SYSTEMS/REVIEWS
Principles of arrangements of heating networks in towns, their automation, and remote control, 3:26549
HEAT EXCHANGERS
See also HEAT PUMPS
Heat exchanger designed as longitudinal counter flow equipment (Patent), 3:26268
HEAT EXCHANGERS/CERAMICS
Development of a ceramic tube heat exchanger with relaxing joint. Quarterly technical progress report, July-October 1, 1977, 3:26152 (FE-2556-09)
HEAT EXCHANGERS/DESIGN
Design and analysis of a cow manure heat exchanger for the 100,000 gallon methane-producing digester in Monroe, Washington, 3:26014 (COO/2991-19)
Direct contact heat exchange for latent heat-of-fusion energy storage systems, 3:26483 (SAND-77-8665)
HEAT EXCHANGERS/EFFICIENCY
Comparison of heat transfer efficiency of gases flowing in smooth and rough channels, 3:26177
HEAT EXCHANGERS/MANUFACTURING
Manufacture of an experimental batch of convective heating surfaces for the Lithuanian district power station, 3:26183
HEAT EXCHANGERS/REPAIR
Process and arrangements for removing a tube from a tube plate (Patent), 3:26379
HEAT EXCHANGERS/RESEARCH PROGRAMS
Development of a ceramic tube heat exchanger with relaxing joint. Quarterly technical progress report, July-October 1, 1977, 3:26152 (FE-2556-09)
HEAT EXCHANGERS/ROUGHNESS
Experimental study of heat exchange in the transcritical region of smooth and rough steam-generating channels, 3:26707
HEAT EXCHANGERS/WELDED JOINTS
Device for welding pipes onto pressurized elements, like tube sheets, pressure vessels, headers and the like (Patent), 3:26380
HEAT FLOW/GREEN FUNCTION
Some functional inequalities, with application to Green's function, 3:27409
HEAT FLOW/MAPS
Flow of heat from the Earth's interior, 3:26108
Temperature/depth distribution in the Federal Republic of Germany, 3:26087 (NP-23046)
HEAT FLOW/MEASURING METHODS
Possible field variant for determining the earth heat flow by the method of temperature waves reduction (TWR), 3:26098
HEAT PIPES/RESEARCH PROGRAMS
Reactor and advanced heat transfer technology, 3:26705 (LA-6807-PR)
HEAT PIPES/TWO-PHASE FLOW
Critical conditions with unsteady-state outflow of a two-phase medium with a pipeline break, 3:26773
HEAT PUMPS/MARKET
Methodology for predicting the demand for new electricity-using goods. Final report, 3:26498 (EPRI-EA-593)
HEAT RECOVERY EQUIPMENT
Development of high temperature dust collector. I, 3:26569
HEAT RECOVERY EQUIPMENT/DESIGN
Smoke tube boiler for heat recovery of hot exhaust gas, 3:26570
HEAT RESISTING ALLOYS/CORROSION
Thermodynamic phase stability diagrams for the analysis of corrosion reactions in coal gasification/combustion atmospheres. Interim report, 3:25626 (EPRI-FP-539)
HEAT TRANSFER
See also HEAT FLOW
THERMAL CONDUCTION
HEAT TRANSFER/COMPUTER CALCULATIONS
Use of general purpose software in casting solidification simulation, 3:26597
HEAT TRANSMISSION
See HEAT TRANSFER
HEAT TREATMENTS/DATA PROCESSING
Development of an aging integrator for uranium-0.75 weight percent titanium alloy part aging control, 3:26595 (Y-2101)
HEATING OILS/CHARGES
Impacts of the national energy programme on solar economics, 3:26051 (LA-UR-78-131)
Prospects for solar energy: the impact of the National Energy Plan (Economic analysis of solar space heating and solar water heating by state), 3:25985 (LA-7064-MS)
HEATING SYSTEMS/PIPES
Instructions for treating internal coatings of man-sized pipes and containers, 3:26552
Instructions for treating internal coatings of man-sized pipes and containers, 3:26552
HEAVY ION REACTIONS
See also CARBON 12 REACTIONS
LITHIUM 7 REACTIONS
NEON 20 REACTIONS
NEON 22 REACTIONS
NITROGEN 14 REACTIONS
OXYGEN 16 REACTIONS
OXYGEN 18 REACTIONS
SULFUR 32 REACTIONS
Nuclear collisions at very high energy, 3:27147 (LBL-6597)
HEAVY ION REACTIONS/DEEP INELASTIC SCATTERING
General form of the cross section of deep inelastic collisions (Semiclassical approximation), 3:27392
HEAVY ION REACTIONS/ELASTIC SCATTERING
Energy dependence in heavy-ion optical-potential elastic scattering, 3:27393
HEAVY ION REACTIONS/MULTI-NUCLEON TRANSFER REACTIONS
Nuclear physics and investigations with multiply charged ions, 3:27316
HEAVY LEPTONS/LEPTONIC DECAY
Cascade decays of heavy leptons produced by neutrinos (Gauge SU(2) x U(1) model), 3:27195
Electron signals from heavy-lepton cascade decays, 3:27190
Experimental limits on heavy lepton production by neutrinos (Mixing angle limits), 3:27106 (BNL-23513)
Lifetimes and branching ratios for heavy-lepton cascades, 3:27188
Like-sign muon-electron production by neutrinos: Key to trilepton mechanisms, 3:27189
Neutral heavy leptons and $e^+ e^-$ colliding-beam experiments, 3:27193
Possible mechanism of direct production of leptons in pN collisions, 3:27237
HEAVY LEPTONS/PAIR PRODUCTION
Can couplings of charged heavy leptons to the W^0 be measured, 3:27174
HEAVY LEPTONS/PARTICLE PRODUCTION
Neutral heavy leptons and $e^+ e^-$ colliding-beam experiments, 3:27193
Possible mechanism of direct production of leptons in pN collisions, 3:27237
Search for heavy particles, 3:27184 (SLAC-PUB-1891)
HEAVY WATER/ATOM-MOLECULE COLLISIONS
Ionizing collisions of cesium and potassium atoms with water, 3:27066
HEAVY WATER COOLANT
See HEAVY WATER
HELA CELLS/CELL CYCLE
Biological effects of ionizing radiation at the molecular, cellular, and organismal levels. Triannual progress report, July 15, 1974-October 14, 1977, 3:26984 (TID-28055)
HELIOSTATS/COMPUTER CALCULATIONS
Educated ray trace approach to solar tower optics, 3:26037
HELIOSTATS/COVERINGS
Central receiver solar thermal power system: collector subsystem. Final report, 3:26035 (SAN/1111-76-7)
HELIOSTATS/DESIGN
Central receiver solar thermal power system: collector subsystem. Final report, 3:26035 (SAN/1111-76-7)
HELIOSTATS/OPTICS
Educated ray trace approach to solar tower optics, 3:26037
HELIOSTATS/PERFORMANCE TESTING
Central receiver solar thermal power system: collector subsystem. Final report, 3:26035 (SAN/1111-76-7)
Infrared television measurement of heliostat images, 3:26075
HELIUM/DE-EXCITATION
Selective single atom detection in a 10^{19} atom background, 3:27062
HELIUM/ELECTRON-ATOM COLLISIONS
Angular distribution of electrons emitted in electron-impact ionization of helium atoms, 3:27083
Time-of-flight spectrometer measurements of elastic-scattering cross sections for electrons with energies of 0.04-1.5 eV in He and Ne, 3:27081
HELIUM/SCHROEDINGER EQUATION
Positivity of an integral connected with the helium atom problem, 3:27408
HELIUM/TEMPERATURE CONTROL
Regulator for controlling liquid helium bath near 4.2 K, 3:26711
HELIUM 3/ELECTRON REACTIONS
Threshold effects in the electrodisintegration of ^{3}He (Stanford Linac) (Monopoles, 170 to 300 MeV, cross section rapid rise), 3:27321 (ORO-4043-37)
HELIUM 3/NUCLEAR FORCES
Electron scattering from ^{3}He and ^{4}He at high momentum transfer, 3:27378 (ORO-4043-37)
HELIUM 3 REACTIONS/CHARGE-EXCHANGE REACTIONS
^{56}Fe(^{3}He,t)^{56}Co reaction, 3:27349
Reappraisal of the ^{24}Mg(^{3}He,t)^{24}Al data to low-lying 1^+ states, 3:27339
HELIUM 3 TARGET/ELECTRON REACTIONS
Electron scattering from ^{3}He and ^{4}He at high momentum transfer, 3:27378 (ORO-4043-37)

Threshold electrodisintegration and quasi-free scattering from ^{3}He (Counts per bin, preliminary results), 3:27322 (ORO-4043-37)
HELIUM 3 TARGET/PION MINUS REACTIONS
Angular distribution of the (π^-,π^0) reaction on ^{3}He at 200 to 290 MeV, 3:27319 (ORO-4043-37)
Elastic scattering of π^{+-} on ^{3}He and ^{3}He (Differential cross sections, 233 to 300 MeV/C experiment in progress), 3:27320 (ORO-4043-37)
Study of ^{3}He(π^-,N)^{2}H and ^{4}He(π^-,N)^{3}H at energies near the (3,3) resonance (Differential cross sections, mechanisms, 50 to 290 MeV), 3:27318 (ORO-4043-37)
HELIUM 3 TARGET/PION PLUS REACTIONS
Elastic scattering of π^{+-} on ^{3}He and ^{3}He (Differential cross sections, 233 to 300 MeV/C experiment in progress), 3:27320 (ORO-4043-37)
HELIUM 3 TARGET/TRITON REACTIONS
Analyzing-power measurements for the ^{3}He(t,d)^{4}He reaction, 3:27324
HELIUM 4
See also HELIUM II
HELIUM 4/HYPERNUCLEI
Possibility of charmed hypernuclei, 3:27228
HELIUM 4/NUCLEAR FORCES
Electron scattering from ^{3}He and ^{4}He at high momentum transfer, 3:27378 (ORO-4043-37)
HELIUM 4 BEAMS/ALIGNMENT
Alignment of helium excited by thin carbon foils (50-500 keV He^+), 3:27075
HELIUM 4 TARGET/ELECTRON REACTIONS
Electron scattering from ^{3}He and ^{4}He at high momentum transfer, 3:27378 (ORO-4043-37)
Threshold electrodisintegration and quasi-free scattering from ^{3}He (Counts per bin, preliminary results), 3:27322 (ORO-4043-37)
HELIUM 4 TARGET/PHOTONUCLEAR REACTIONS
Eikonal and quasi-eikonal models in the theory of complex angular momenta for pion elastic scattering and rho^0-meson photoproduction on ^{4}He nuclei, 3:27235
HELIUM 4 TARGET/PION MINUS REACTIONS
Study of ^{3}He(π^-,N)^{2}H and ^{4}He(π^-,N)^{3}H at energies near the (3,3) resonance (Differential cross sections, mechanisms, 50 to 290 MeV), 3:27318 (ORO-4043-37)
Study of pion-absorption mechanisms in ^{4}He and other nuclei, 3:27323
HELIUM 4 TARGET/PION PLUS REACTIONS
Study of pion-absorption mechanisms in ^{4}He and other nuclei, 3:27323
HELIUM 4 TARGET/PION REACTIONS
Eikonal and quasi-eikonal models in the theory of complex angular momenta for pion elastic scattering and rho^0-meson photoproduction on ^{4}He nuclei, 3:27235
HELIUM 4 TARGET/PROTON REACTIONS
Statistical analysis of ^{4}He(p,p)^{4}He data, 3:27325
HELIUM II/VISCOSITY
Transport properties of helium II in fine channels, 3:27095 (AD-239477)
HELIUM IONS/ION-ATOM COLLISIONS
Alignment of helium excited by thin carbon foils (50-500 keV He^+), 3:27075
Electron loss by atomic and molecular hydrogen in collisions with $^3He^{++}$ and $^4He^+$, 3:27076
HELIUM IONS/ION-MOLECULE COLLISIONS
Electron loss by atomic and molecular hydrogen in collisions with $^3He^{++}$ and $^4He^+$, 3:27076
HELIUM-NEON LASERS/EFFICIENCY
Influence of resonant properties of the discharge of He-Ne laser emission, 3:26751
HELIUM-NEON LASERS/MIXING
Use of metal-oxide-metal diode for multiplying and mixing laser frequencies within the near infrared and the visible range (CO_2 and He--Ne lasers), 3:26755
HELIUM-NEON LASERS/POPULATION INVERSION
Modulation spectroscopy of He-Ne laser levels, 3:26746
HEMATOPOIESIS
See BLOOD FORMATION
HEMATOPOIETIC SYSTEM/BIOCHEMISTRY
Inborn anemias in mice. Progress report, 1 May 1976-31 July 1977, 3:26987 (COO-3264-16)
HEMATOPOIETIC SYSTEM/CHRONIC IRRADIATION
^{239}Pu and ^{241}Am contamination of small vertebrates in NAEG study areas of NTS and TTR, 3:26915 (NVO-171)
HEMATOPOIETIC SYSTEM/GENETICS
Inborn anemias in mice. Progress report, 1 May 1976-31 July 1977, 3:26987 (COO-3264-16)
HEMATOPOIETIC SYSTEM/METABOLISM
Inborn anemias in mice. Progress report, 1 May 1976-31 July 1977, 3:26987 (COO-3264-16)
HEMATOPOIETIC SYSTEM/PATHOLOGICAL CHANGES
^{239}Pu and ^{241}Am contamination of small vertebrates in NAEG study areas of NTS and TTR, 3:26915 (NVO-171)
HEMATOPOIETIC SYSTEM/RADIOSENSITIVITY
Inborn anemias in mice. Progress report, 1 May 1976-31 July 1977, 3:26987 (COO-3264-16)
HEMOPOIESIS
See BLOOD FORMATION
HEPTANE/REFORMER PROCESSES
Studies on catalysts for low-temperature steam-reforming of hydrocarbons. IV. Kinetics of reaction on the Rh-$MgWO_4$ catalyst, 3:25784
HEREDITY
See GENETICS
HEXENES/HYDROGENATION
Hydrogenation of hexene over platinum on alumina vs. platinum in a Na-Y zeolite, 3:26684
HIGGS MODEL/CHARGED PARTICLES
Singular pseudoparticles in Higgs theories, 3:27156
HIGGS MODEL/CP INVARIANCE
CP violation, radiative symmetry-breaking effects, and Higgs-particle and fermion masses, 3:27247
HIGGS MODEL/GAUGE INVARIANCE
Singular pseudoparticles in Higgs theories, 3:27156
HIGGS MODEL/VACUUM STATES
Vacuum structure of the two-dimensional Higgs model, 3:27260
HIGH ENERGY PHYSICS/RESEARCH PROGRAMS
Progress report for a research program in theoretical high-energy physics, 3:27146 (COO-3130TA-340)
HIGH EXPLOSIVES
See CHEMICAL EXPLOSIVES
HIGH-BETA PLASMA/MEETINGS
Plasma theory. Report on the third international (Kiev) conference held at Trieste, 5 - 9 April 1977, 3:27527
HIGH-FREQUENCY HEATING
See also ICR HEATING
MAGNETIC-PUMPING HEATING
Plasma heating in a toroidal system by a helical quadrupole RF field with $\omega < \omega$sub(Bi), 3:27452
HIGH-FREQUENCY HEATING/BOUNDARY CONDITIONS
Plasma edge cooling during RF heating, 3:27436 (PPPL-1416)
HIGH-FREQUENCY HEATING/ENERGY LOSSES
Plasma edge cooling during RF heating, 3:27436 (PPPL-1416)
HIGH-FREQUENCY HEATING/HYBRID RESONANCE
Theoretical investigations of lower hybrid resonance heating in a tokamak, 3:27433 (JAERI-M-6964)
HIGH-FREQUENCY HEATING/POWER CONDITIONING CIRCUITS
Sources for high frequency heating. Performance and limitations, 3:27653 (CEA-CONF-3865)
HIGH-TEMPERATURE FUEL CELLS/ELECTROLYTES
Advanced fuel cell development. Progress report, July-September 1977 (β-$LiAlO_2$ electrolytes), 3:26542 (ANL-77-79)
HIGH-TEMPERATURE FUEL CELLS/PERFORMANCE TESTING
Advanced fuel cell development. Progress report, July-September 1977 (β-$LiAlO_2$ electrolytes), 3:26542 (ANL-77-79)
HIGH-TEMPERATURE FUEL CELLS/RESEARCH PROGRAMS
Advanced fuel cell development. Progress report, July-September 1977 (β-$LiAlO_2$ electrolytes), 3:26542 (ANL-77-79)
Advanced technology fuel cell program. Interim report, 3:26543 (EPRI-EM-576)
HIGH-TEMPERATURE GAS-COOLED REACTOR
See HTGR TYPE REACTORS
HIGHWAYS
See ROADS
HOLMIUM 165/GIANT RESONANCE
Investigation of giant multipole resonances in medium and heavy nuclei by inelastic electron scattering. Final technical report, 15 October 1974-31 October 1976, 3:27356 (AD-A-042298)
HOLMIUM 165 TARGET/ELECTRON REACTIONS
Investigation of giant multipole resonances in medium and heavy nuclei by inelastic electron scattering. Final technical report, 15 October 1974-31 October 1976, 3:27356 (AD-A-042298)
HOLMIUM 165 TARGET/PION MINUS REACTIONS
Pion cross section measurements on aligned ^{165}Ho in the (3,3) resonance region, 3:27375
HOLMIUM 165 TARGET/PION PLUS REACTIONS
Pion cross section measurements on aligned ^{165}Ho in the (3,3) resonance region, 3:27375
HOLMIUM COMPOUNDS/KNIGHT SHIFT
Systematics in the Knight shift of rare-earth monopnictides, 3:26600
HOMOGENEOUS PLASMA/EMISSION SPECTRA
Spectral-line-blending calculations applied to highly excited atomic levels in high-density argon plasmas, 3:27516
HOMOGENEOUS PLASMA/LANDAU DAMPING
Electron Landau damping and electron collisions, 3:27571
HORIZONTAL DIVESTITURE/EVALUATION
Divestiture: the pros and cons, 3:26520

HORMONES/BIOSYNTHESIS
Challenge of pineal gland structure and function (^{125}I tracer technique), 3:26983 (CONF-770504-)
HOT PLASMA
See also LASER-PRODUCED PLASMA
HOT PLASMA/CHARGED-PARTICLE TRANSPORT
Moment method for calculating the transport of energetic charged particles in hot plasmas, 3:27522
HOT PLASMA/RECOMBINATION
Dielectronic recombination of carbon, oxygen and iron in low-density and high-temperature plasmas, 3:27505 (JAERI-M-7019)
HOT SPRINGS/GEOCHEMISTRY
Chemical components of hot springs in Nagano Prefecture, 3:26102
HOT-DRY-ROCK SYSTEMS/CRACKS
Heat extraction from hot, dry rock masses. Progress report, 1 August 1976-31 January 1977, 3:26106 (PB-271411)
HOT-DRY-ROCK SYSTEMS/DRILL CORES
Iotopic evidence for local derivation of strontium in deep-seated, fracture-filling calcite from granitic rocks in drill hole GT-2, Los Alamos Scientific Laboratory Dry Hot Rock Program, 3:26103
HOT-DRY-ROCK SYSTEMS/HEAT EXTRACTION
Heat extraction from hot, dry rock masses. Progress report, 1 August 1976-31 January 1977, 3:26106 (PB-271411)
HOUSES/SOLAR HEATING SYSTEMS
Solar house heating system using reflective pyramid optical condensing system. Final report. Evaluation of performance, June 1, 1975-December 31, 1976, 3:26045 (COO/2769-2)
HTGR TYPE REACTORS
See also THTR-300 REACTOR
VRAIN REACTOR
Energy from nuclear reactors. Pt. 6. The gas-cooled HTR: reactivation of coal, 3:26340
HTGR TYPE REACTORS/COAL GASIFICATION
Energy from nuclear reactors. Pt. 8. Two coal gasification procedures using reactor heat - 70% conversion efficiency, 3:26260
HTGR TYPE REACTORS/COATED FUEL PARTICLES
COPAR, a program to compute release of metallic fission products from coated particles, 3:26254 (GA-A-14034)
Method and device for coating of particles, containing fissile, fertile or absorber material, used for HTR fuel elements (Patent), 3:26270
Method for the coating of particles with single layers of pyrolytic carbon having different densities (Patent), 3:26269
Pyrocarbon-coated fuel particles for fuel elements of HTR reactors (Patent), 3:26264
HTGR TYPE REACTORS/CONTROL ELEMENTS
Device for measuring the position of control rods in nuclear reactors (Patent), 3:26410
HTGR TYPE REACTORS/COOLANTS
Layout of the reactor cores of gas-cooled HTR-type reactors. Pt. 1. Calculation of the physical characteristics of helium. Draft, 3:26259
HTGR TYPE REACTORS/HEAT EXCHANGERS
Heat exchanger designed as longitudinal counter flow equipment (Patent), 3:26268
HTGR TYPE REACTORS/REACTOR CORES
Status of the General Atomic HTGR core seismic verification program, 3:26434 (GA-A-14592)
HTGR TYPE REACTORS/REACTOR FUELING
Refuelling system for a nuclear reactor with a reactor core exhibiting a pebble bed of spherical fuel elements (Patent), 3:26267
HTGR TYPE REACTORS/REACTOR SAFETY
High-temperature gas-cooled reactor safety studies for the Division of Reactor Safety Research. Quarterly progress report, July 1-September 30, 1977, 3:26255 (ORNL/NUREG/TM-164)
HUMAN CELLS
See ANIMAL CELLS
HUMAN POPULATIONS/BIOLOGICAL RADIATION EFFECTS
Competing risk model for reduction in life expectancy from radiogenic latent cancer (Radiation exposure as result of nuclear reactor accidents), 3:26985 (SAND-77-1352C)
HUMAN POPULATIONS/DISTRIBUTION
Calculation of population distribution using a computer data base, 3:26939 (BNWL-2395)
HUMAN POPULATIONS/DOSE COMMITMENTS
Population dose commitments due to radioactive releases from nuclear power plant sites in 1975, 3:26992 (PNL-2439)
HUMAN POPULATIONS/HEALTH HAZARDS
Comparative effects of coal and nuclear fuel on mortality, 3:26871 (BNL-23579)
HUMAN POPULATIONS/LIFE SPAN
Competing risk model for reduction in life expectancy from radiogenic latent cancer (Radiation exposure as result of nuclear reactor accidents), 3:26985 (SAND-77-1352C)
HUMAN POPULATIONS/MORTALITY
Comparative effects of coal and nuclear fuel on mortality, 3:26871 (BNL-23579)
Population hazards associated with fossil fuel and nuclear power production, 3:26419
HUMAN POPULATIONS/OCCUPATIONS
Prehistoric human occupation of the Rat Islands, 3:26898 (TID-26712)
HUMAN POPULATIONS/RADIATION DOSES
Detailed accident analysis for the high level waste preparation phase of the commercial nuclear waste vitrification project, 3:26989 (BNWL-2207)
Jeremiah environmental computational system (Monitoring radioactive effluents from nuclear fuel cycle), 3:26887 (DP-MS-77-41)
Population dose commitments due to radioactive releases from nuclear power plant sites in 1975, 3:26992 (PNL-2439)
HUMAN POPULATIONS/SOCIOLOGY
Previous scientific investigations, 1867-1967, 3:26899 (TID-26712)
HUNGARIAN PAKS-1 REACTOR
See PAKS-1 REACTOR
HYBRID ELECTRIC-POWERED VEHICLES/MEETINGS
Electric Hybrid Vehicle Program contractors' coordination meeting: summary, oversight, and review, 3:26581 (UCRL-13805)
HYBRID ELECTRIC-POWERED VEHICLES/SIMULATION
Hybrid vehicle simulation program (Rev. 1), 3:26582 (COO/2835-1)
HYBRID ELECTRIC-POWERED VEHICLES/STANDARDS
Evaluation and recommendation of electric and hybrid vehicle performance standards. Final report, 3:26579 (CONS/5053-1)
HYBRID ELECTRIC-POWERED VEHICLES/TECHNOLOGY ASSESSMENT
State-of-the-art assessment of electric and hybrid vehicles, 3:26580 (HCP/M1011-01)
HYBRID REACTORS/ADIABATIC COMPRESSION HEATING
Pure-fusion and fusion-fission reactor applications of high-density linear confinement systems, 3:27454
HYBRID REACTORS/COMPARATIVE EVALUATIONS
Laser driven fusion fission hybrids, 3:27681 (UCRL-79653(Rev.1))
HYBRID REACTORS/LASER-RADIATION HEATING
Pure-fusion and fusion-fission reactor applications of high-density linear confinement systems, 3:27454
HYDRATED ELECTRONS
See SOLVATED ELECTRONS
HYDRAULIC MINING/BENCH-SCALE EXPERIMENTS
Studies on the flow characteristics of high speed water jets in air: the breakup characteristics of the water jet atomizer (2nd report), 3:25696
HYDROCARBON FUEL CELLS/RESEARCH PROGRAMS
Advanced technology fuel cell program. Interim report, 3:26543 (EPRI-EM-576)
HYDROCARBONS
See also ALKANES
ALKENES
ALKYNES
ANTHRACENE
BENZENE
BENZOPYRENE
TETRALIN
HYDROCARBONS/CHEMILUMINESCENCE
Chemical production of excited states: adventitious biological chemiluminescence of carcinogenic polycyclic aromatic hydrocarbons, 3:26946 (COO-3277-44)
HYDROCARBONS/DEWAXING
Combined process of partial deparaffination and de-oiling of solid hydrocarbons, 3:25769
HYDROCARBONS/OXIDATION
Distinctive catalysis by phosphonium and sulfonium compounds in low-temperature liquid-phase hydrocarbon oxidation, 3:26688
HYDROCARBONS/PROCESSING
Adances in petrochemical technology, 3:25765
HYDROCARBONS/PYROLYSIS
Developments in olefins production technology, 3:25767
HYDROCARBONS/REFINING
Combined process of partial deparaffination and de-oiling of solid hydrocarbons, 3:25769
HYDROCARBONS/STEAM REFORMER PROCESSES
Steam reforming of hydrocarbons on alkali polyaluminate catalysts. II. Reactivity of deposited carbon, 3:25785
HYDROCARBONS/THERMODYNAMIC PROPERTIES
Chemical thermodynamic properties of ethylbenzene, 3:27414
HYDROCRACKING
See also CATALYTIC CRACKING
HYDROCRACKING/CATALYSTS
Use of a third-order Latin square in selecting hydrocracking catalysts, 3:25775

HYDROCRACKING/CHEMICAL REACTION KINETICS
Steam reforming of hydrocarbons on alkali polyaluminate catalysts. II. Reactivity of deposited carbon, 3:25785
HYDROCRACKING/OPTIMIZATION
Optimal conditions for selective hydrocracking of raffinates, 3:25773
HYDRODYNAMIC MODEL/RESONANCE PARTICLES
Hydrodynamic model of collective resonances in hadronic matter, 3:27220
HYDRODYNAMICS
See also MAGNETOHYDRODYNAMICS
HYDRODYNAMICS/CONVECTIVE INSTABILITIES
Instabilities in fluid layers and in reaction-diffusion systems: Steady states, time-periodic solutions, non-periodic attractors, and related convective and otherwise non-linear phenomena, 3:27542 (JEN-379)
HYDROELECTRIC POWER/EVALUATION
Upper Mississippi River Basin above Minnesota River, Minnesota. Appraisal report, water resources appraisal for hydroelectric licensing, 3:25977 (NP-22953)
HYDROELECTRIC POWER PLANTS
See also PUMPED STORAGE POWER PLANTS
HYDROELECTRIC POWER PLANTS/CONSTRUCTION
All-union red labor banner order-bearing trust, "spetsgidroenergomontazh", 3:25980
HYDROELECTRIC POWER PLANTS/DAMS
Investigation of failure of Walter :Bouldin Dam FPC project No. 2146 and safety of other dams of the Alabama Company FPC project Nos. 82, 349, 618, 2146, 2165, 2203, 2407, 2408, 2628, 3:25975 (NP-23020)
Powerhouse intake gate catapult study, Big Bend Dam, South Dakota, and Stockton, Harry S. Truman, and Clarence Cannon Dams, Missouri. Hydraulic model investigation. Final report, December 1973-January 1976, 3:25979 (AD-A-043876)
HYDROELECTRIC POWER PLANTS/ECONOMICS
Water resources appraisal for hydroelectric licensing. Evaluation report, project No. 287, 3:25976 (NP-22951)
HYDROELECTRIC POWER PLANTS/ELECTRIC GENERATORS
Dynamic stability of hydraulic generators operating under the conditions of consumption of reactive capacity, 3:25981
HYDROELECTRIC POWER PLANTS/LICENSING
Upper Mississippi River Basin above Minnesota River, Minnesota. Appraisal report, water resources appraisal for hydroelectric licensing, 3:25977 (NP-22953)
Water resources appraisal for hydroelectric licensing. Evaluation report, project No. 287, 3:25976 (NP-22951)
Water resources appraisal for hydroelectric licensing, Kern River Basin, California, 3:25978 (TID-28173)
HYDROELECTRIC POWER PLANTS/MODIFICATIONS
Water resources appraisal for hydroelectric licensing. Evaluation report, project No. 287, 3:25976 (NP-22951)
HYDROELECTRICITY
See HYDROELECTRIC POWER
HYDROGEN/ATOM-ATOM COLLISIONS
Collisions of H^- ions and fast H^0 atoms in a Cs vapor target, 3:27068
HYDROGEN/CHEMICAL REACTION KINETICS
Mechanism of methanol synthesis from carbon dioxide and hydrogen. III. Determination of rates of individual stages using ^{14}CO, 3:25967
Rate parameters for the reactions of formaldehyde with H-atoms and O-atoms over the temperature range 250 to 470 K, 3:26670 (BNL-23550)
HYDROGEN/CHEMICAL REACTIONS
Reactions of thiophene with radiolytically produced radicals. II. The solvated electron and the hydrogen atom, 3:26696
HYDROGEN/DEMAND FACTORS
Hydrogen consumption in non-catalyzed coal liquefaction, 3:25664 (SAND-77-1560C)
HYDROGEN/ELECTRON-MOLECULE COLLISIONS
Rotational resonances in low-energy electron scattering by H_2 and D_2, 3:27071
HYDROGEN/ENERGY TRANSPORT
Prospects for the use of hydrogen as an energy carrier, 3:25963 (CONF-771039-10)
HYDROGEN/GEOCHEMISTRY
Hydrogen - a reducing agent in some uranium deposits, 3:25904
HYDROGEN/ION-ATOM COLLISIONS
Electron loss by atomic and molecular hydrogen in collisions with $^3He^{++}$ and $^4He^+$, 3:27076
HYDROGEN/ION-MOLECULE COLLISIONS
Electron loss by atomic and molecular hydrogen in collisions with $^3He^{++}$ and $^4He^+$, 3:27076
HYDROGEN/LIQUEFACTION
Studies of hydrogen liquefier efficiency and the recovery of the liquefaction energy, 3:25957 (PB-274058)
HYDROGEN/METABOLISM
Effect of light on respiration and development of photosynthetic cells. Progress report, June 1, 1976-August 31, 1977 (Chlamydomonas, Euglena, spinach, peas), 3:26969 (COO-3231-5)
HYDROGEN/RAMAN SPECTRA
Coherent anti-stokes Raman spectroscopy. Final report, 3:26669 (AD-A-042273)
HYDROGEN/RECYCLING
Research and development of rapid hydrogenation for coal conversion to synthetic motor fuels (riser cracking of coal). Second quarter report, July 1-September 30, 1977, 3:25656 (FE-2307-25)
HYDROGEN/SELF-DIFFUSION
Study of self-diffusion in dense hydrogen gas by quasielastic incoherent neutron scattering, 3:26592
HYDROGEN 2
See DEUTERIUM
HYDROGEN GENERATORS/HEAT SOURCES
Powdered metal source for production of heat and hydrogen gas (Patent; micro-electrochemical cell), 3:25958
HYDROGEN IONS 1 MINUS/ATOM-ATOM COLLISIONS
Collisions of H^- ions and fast H^0 atoms in a Cs vapor target, 3:27068
HYDROGEN IONS 1 MINUS/ELECTRON DETACHMENT
Effect of an electric field upon resonances in the H^- ion, 3:27058
HYDROGEN IONS 1 MINUS/ION-ATOM COLLISIONS
Collisions of H^- ions and fast H^0 atoms in a Cs vapor target, 3:27068
HYDROGEN IONS 1 MINUS/PENNING ION SOURCES
Cathode cooling systems for the magnetron and Penning H^- sources: a progress report of work at Brookhaven National Laboratory, 3:26801 (BNL-23654)
HYDROGEN IONS 1 MINUS/PHOTON-ION COLLISIONS
Effect of an electric field upon resonances in the H^- ion, 3:27058
HYDROGEN IONS 1 PLUS/ION-ATOM COLLISIONS
K-shell capture by protons from O_2, N_2, and Ne, 3:27070
HYDROGEN IONS 1 PLUS/ION-MOLECULE COLLISIONS
K-shell capture by protons from O_2, N_2, and Ne, 3:27070
HYDROGEN PRODUCTION
See also HYDROGEN GENERATORS
STEAM-IRON PROCESS
Powdered metal source for production of heat and hydrogen gas (Patent; micro-electrochemical cell), 3:25958
HYDROGEN PRODUCTION/KOPPERS-TOTZEK PROCESS
Quarterly technical progress report, October-December 1977, 3:25631 (FE-2240-79)
HYDROGEN PRODUCTION/PARTIAL OXIDATION PROCESSES
Partial oxidation of fuel oil route to methanol production, 3:25966
HYDROGEN PRODUCTION/STEAM-IRON PROCESS
Development of the steam-iron process for hydrogen production. Project 9010 quarterly report No. 4, April 1-June 30, 1977, 3:25961 (FE-2435-16)
Quarterly technical progress report, October-December 1977, 3:25631 (FE-2240-79)
HYDROGEN PRODUCTION/THERMOCHEMICAL PROCESSES
Assessment of thermochemical hydrogen production (Fe-Cl cycle), 3:25960 (NP-22964)
Efficiencies of various methods for solar energy conversion, 3:25986 (AD-A-042584)
Status of European thermochemical hydrogen programs, 3:25959 (LA-UR-77-2985)
HYDROGEN STORAGE
See also CRYOGENICS
TANKS
HYDROGEN STORAGE/IRON HYDRIDES
Hydrogen compatibility of structural materials for energy storage and transmission applications. Semiannual report, April 1, 1977-October 1, 1977, 3:25962 (SAND-77-8296)
HYDROGEN STORAGE/TITANIUM HYDRIDES
Hydrogen compatibility of structural materials for energy storage and transmission applications. Semiannual report, April 1, 1977-October 1, 1977, 3:25962 (SAND-77-8296)
HYDROGEN SULFIDES/CHEMICAL REACTIONS
Study of the mechanism of the hydrogen sulfide/dolomite reaction. Quarterly report, July 1977-October 1977, 3:25681 (FE-2408-5)
HYDROGEN SULFIDES/CORROSIVE EFFECTS
Study of plant metallurgical requirements for low-Btu gasification of coal for electric power generation, 3:25629 (FE-1545-39)
HYDROGEN SULFIDES/EQUILIBRIUM
Preparation of a coal conversion systems technical data book. Project 8979 quarterly report, May 1-July 31, 1977 (NH_3-CO_2-H_2S-H_2O, cyclohexane-H_2O), 3:25633 (FE-2286-20)
HYDROGEN SULFIDES/OXIDATION
Complete catalytic oxidation of vapor mixtures containing phenol and hydrogen sulfide, 3:26678

HYDROGEN SULFIDES/REMOVAL
Corrosion control in gas processing plants which remove CO_2 and H_2S (Monoethanolamine), 3:25768
HYDROTHERMAL SYSTEMS/FLUID FLOW
Transport phenomena in hydrothermal systems: the nature of porosity, 3:26083
Transport phenomena in hydrothermal systems: cooling plutons, 3:26084
HYDROTHERMAL SYSTEMS/GEOTHERMOMETRY
Use of geothermometer models in the exploration for a hydrogeothermal resource, 3:26097
HYDROTHERMAL SYSTEMS/HEAT TRANSFER
Transport phenomena in hydrothermal systems: cooling plutons, 3:26084
HYDROTHERMAL SYSTEMS/MATHEMATICAL MODELS
Transport phenomena in hydrothermal systems: cooling plutons, 3:26084
HYDROTHERMAL SYSTEMS/TEMPERATURE MEASUREMENT
Use of geothermometer models in the exploration for a hydrogeothermal resource, 3:26097
HYDROXYBENZENE
See PHENOL
HYDROXYL RADICALS/CHEMICAL REACTIONS
Reactions of thiophene with radiolytically produced radicals. I. The hydroxyl radical, 3:26695
HYGAS PROCESS/COMPARATIVE EVALUATIONS
Quarterly technical progress report, October-December 1977, 3:25631 (FE-2240-79)
HYGAS PROCESS/DEMONSTRATION PLANTS
Fossil energy demonstration plants, 3:25642 (TID-28182)
HYGAS PROCESS/ENVIRONMENTAL IMPACTS
Environmental aspects of the HYGAS Process, 3:25624 (CONF-780305-10)
Environmental assessment of the HYGAS Process. Project No. 9025 monthly progress report, July 1-July 31, 1977, 3:25636 (FE-2433-17)
Environmental assessment of the HYGAS Process. Project No. 9025 monthly progress report, August 1-August 31, 1977, 3:25637 (FE-2433-18)
HYGAS PROCESS/MATERIAL BALANCE
Fate of trace and minor constituents of coal during gasification. Final task report, 3:25641 (PB-270913)
HYGAS PROCESS/METHANATION
Operating experience with the IGT cold-gas recycle methanation process in the HYGAS pilot plant, 3:25623 (CONF-771092-9)
HYGAS PROCESS/PILOT PLANTS
Failure of the thermocouple assembly from the HYGAS coal pretreatment vessel: failure analysis report, 3:25621 (ANL/MSD/FE-77-6R)
HYPERFRAGMENTS
See HYPERNUCLEI
HYPERNUCLEI/CHARM PARTICLES
Possibility of charmed hypernuclei, 3:27228

I

ICELAND/GLACIERS
Explanation of Joekulhlaups from Grimsvoetn, Vatnajoekull, Iceland, 3:26090
ICELAND/HYDROLOGY
Explanation of Joekulhlaups from Grimsvoetn, Vatnajoekull, Iceland, 3:26090
ICR HEATING
Eigenmode field structure of the fast magnetosonic wave in a Tokamak and loading impedance of coupling structures, 3:27428 (EUR-CEA-FC-886)
Heating tokamaks via the ion-cyclotron and ion-ion hybrid resonances, 3:27584
Ion cyclotron resonance heating in the Wisconsin supported toroidal octupole, 3:27450
IDAHO/ENERGY SOURCE DEVELOPMENT
Western States energy resource development update 1976, 3:26503
IDAHO/ENERGY SUPPLIES
Northwest Energy Policy Project. Energy supply and environmental impacts: conventional energy sources. Study Module III-A final report, 3:26512 (NP-23054)
IGNEOUS ROCKS
See also BASALT
GRANITES
GRANODIORITES
LAVA
VOLCANIC ROCKS
IGNEOUS ROCKS/ACTIVATION ANALYSIS
Uranium abundance in some Precambrian and Phanerozoic rocks from New Mexico, 3:25912
IGNEOUS ROCKS/AGE ESTIMATION
Chemical data and variation diagrams of igneous rocks from the Timber Mountain-Oasis Valley, Caldera Complex, southern Nevada, 3:27018 (USGS-OFR-77-724)
IGNEOUS ROCKS/CHEMICAL COMPOSITION
Chemical data and variation diagrams of igneous rocks from the Timber Mountain-Oasis Valley, Caldera Complex, southern Nevada, 3:27018 (USGS-OFR-77-724)
IGNEOUS ROCKS/COOLING
Cooling rate and geothermal potential of silicic plutons: effect of size, shape, depth, and thermal parameters (abstract), 3:26117
Transport phenomena in hydrothermal systems: cooling plutons, 3:26084
IGNEOUS ROCKS/HEAT TRANSFER
Cooling rate and geothermal potential of silicic plutons: effect of size, shape, depth, and thermal parameters (abstract), 3:26117
IGNEOUS ROCKS/POROSITY
Transport phenomena in hydrothermal systems: the nature of porosity, 3:26083
IGNEOUS ROCKS/ROCK-FLUID INTERACTIONS
Transport phenomena in hydrothermal systems: cooling plutons, 3:26084
ILEUM
See SMALL INTESTINE
ILLINOIS/POLLUTION REGULATIONS
Cost/effectiveness analysis of the Illinois ozone episode regulation (R75-4). Final Report, 3:26890 (PB-270896)
IMAGE PROCESSING/COMPUTER CALCULATIONS
Image restoration of space variant blurs by sectioned methods, 3:27705 (LA-UR-77-2876)
IMAGE PROCESSING/DIGITAL FILTERS
Design of stable 2-D half-plane recursive filters using spectral factorization, 3:27711 (UCRL-80078)
IMPERMEABLE DRY ROCK
See HOT-DRY-ROCK SYSTEMS
IMPLOSIONS
See also LASER IMPLOSIONS
IMPLOSIONS/RAYLEIGH-TAYLOR INSTABILITY
Stability of ablation and combustion fronts, 3:27089
IN CORE INSTRUMENTS
(See also specific instruments.)
IN CORE INSTRUMENTS/CONNECTORS
Manufacture of an interconnector (Patent), 3:26381
IN CORE INSTRUMENTS/FAILED ELEMENT MONITORS
Relation between fuel motion and detector response for in-core fuel motion detection systems, 3:26358 (SAND-77-0533C)
INCIDENTS
See ACCIDENTS
INCOLOY 800/STRESS CORROSION
Advanced coal gasification system for electric power generation. Sixty-third monthly progress report, October 1977, 3:25628 (FE-1514-73)
INCOMPRESSIBLE FLOW/FLOW MODELS
Numerical method of determination of hydrodynamic conductibility of a nonhomogeneous oil-bearing stratum, 3:25750
INCONEL 600/COMPATIBILITY
Compatibility testing of vitrified waste forms, 3:25936 (DP-MS-77-115)
INCONEL 706/PHYSICAL RADIATION EFFECTS
US experience in irradiation testing of advanced oxide fuels (LMFBR), 3:26303
IN-CORE FUEL MANAGEMENT
See FUEL MANAGEMENT
INDEPENDENT-PARTICLE MODEL
See SINGLE-PARTICLE MODEL
INDIA/WIND POWER
Wind power for india, 3:26125
INDIUM/ION EXCHANGE
Cation exchange of 53 elements in nitric acid, 3:26665 (LA-7083)
INDIUM 115 TARGET/PHOTONUCLEAR REACTIONS
Pre-equilibrium particle decay in the photonuclear reactions, 3:27327
INDIUM 115 TARGET/PROTON REACTIONS
Anomalous optical-model potential for sub-Coulomb protons for $89 < A < 130$, 3:27361
INDIUM ALLOYS/ELECTRIC CONDUCTIVITY
Thermal conductivity of indium: mercury amalgams, 3:26614
INDIUM ALLOYS/THERMAL CONDUCTIVITY
Thermal conductivity of indium: mercury amalgams, 3:26614
INDUSTRIAL PLANTS
See also ISOTOPE SEPARATION PLANTS
OIL SAND PROCESSING PLANTS
PETROCHEMICAL PLANTS
WASTE PROCESSING PLANTS

INDUSTRIAL PLANTS/ENERGY LOSSES
Strategy for energy conservation through tribology, 3:26706 (TID-28175)
INDUSTRIAL PLANTS/FLUE GAS
Survey of the application of flue gas desulfurization technology in the industrial sector, 3:26786 (PB-270548)
INDUSTRIAL WASTES
See also REFUSE DERIVED FUELS
INDUSTRIAL WASTES/INVENTORIES
Potential environmental impact of compounding and fabricating industries: a preliminary assessment. Final report, 3:26936 (PB-273603)
INDUSTRY
See also CHEMICAL INDUSTRY
COAL INDUSTRY
FISHING INDUSTRY
FOOD INDUSTRY
GLASS INDUSTRY
METAL INDUSTRY
NATURAL GAS INDUSTRY
OIL SHALE INDUSTRY
PETROLEUM INDUSTRY
INDUSTRY/ENERGY ACCOUNTING
Energy audits for industry, 3:26556
INDUSTRY/HEAT RECOVERY EQUIPMENT
Development of high temperature dust collector. I, 3:26569
INDUSTRY/POLLUTION CONTROL EQUIPMENT
Development of high temperature dust collector. I, 3:26569
INELASTIC SCATTERING/FORM FACTORS
Allowance for higher orders of the nuclear-surface deformation in calculations of elastic and inelastic nuclear form factors, 3:27395
INFORMATION SYSTEMS/COMPARATIVE EVALUATIONS
ESCOE engineering program. Quarterly report, September 1-November 30, 1977, 3:25638 (FE-2468-18)
INFRARED THERMOGRAPHY/USES
Infrared television measurement of heliostat images, 3:26075
INHOMOGENEOUS PLASMA/ALFVEN WAVES
Phase mixing in the continuous spectrum of Alfven waves, 3:27572
INHOMOGENEOUS PLASMA/CYCLOTRON INSTABILITY
Nonlinear dynamics of drift-cyclotron instability, 3:27548
INHOMOGENEOUS PLASMA/DIFFUSION
Quasi-linear diffusion and particle transport in inhomogeneous plasmas, 3:27510
INHOMOGENEOUS PLASMA/DRIFT INSTABILITY
Nonlinear dynamics of drift-cyclotron instability, 3:27548
INHOMOGENEOUS PLASMA/ELECTROMAGNETIC RADIATION
Modulation of electromagnetic waves in an isotropic inhomogeneous plasma, 3:27590
INHOMOGENEOUS PLASMA/ENERGY ABSORPTION
Electromagnetic structure resonances in inhomogeneous plasma layers, 3:27441
INHOMOGENEOUS PLASMA/LASER-RADIATION HEATING
Nonlinear penetration of an inhomogeneous laser beam in an overdense plasma, 3:27449
INHOMOGENEOUS PLASMA/TURBULENCE
Quasi-linear diffusion and particle transport in inhomogeneous plasmas, 3:27510
INSECTS/COMMUNITIES
Biotic components, 3:25946 (PNL-2253)
IN-SITU GASIFICATION/ENVIRONMENTAL EFFECTS
Effects of underground coal gasification on ground-water quality, 3:25644 (UCRL-80145)
IN-SITU GASIFICATION/REVIEWS
Future use of coal in energy generation, 3:25723
INSOLATION/MEASURING INSTRUMENTS
Precision insolation measurement under field conditions, 3:25984
INSTANTONS/PARTICLE INTERACTIONS
Geometry and interactions of instantons (SU(4) and SU(2) groups, gauge fields), 3:27182
INSTRUMENTS (MEASURING)
See MEASURING INSTRUMENTS
INSULATION (THERMAL)
See THERMAL INSULATION
INTAKE STRUCTURES/PERFORMANCE TESTING
Powerhouse intake gate catapult study, Big Bend Dam, South Dakota, and Stockton, Harry S. Truman, and Clarence Cannon Dams, Missouri. Hydraulic model investigation. Final report, December 1973-January 1976, 3:25979 (AD-A-043876)
INTAKE STRUCTURES/SUPERSONIC FLOW
Accelerated iterative calculation of transonic nacelle flowfields, 3:27091
INTEGRAL EQUATIONS
See also LIPPMANN-SCHWINGER EQUATION
INTEGRAL EQUATIONS/EIGENVALUES
Some recent results in bifurcation theory, 3:27421
INTEGRAL EQUATIONS/NUMERICAL SOLUTION
Collocation methods for integro-differential equations, 3:27713
INTEGRATED CIRCUITS/PHYSICAL RADIATION EFFECTS
Integrated circuit electromagnetic susceptibility investigation. phase III. Summary report No. 2, 3:26834 (AD-A-043776)
Integrated circuit electromagnetic susceptibility investigation. Phase III. IC susceptibility handbook-draft 2, 3:26835 (AD-A-043777)
INTEGRATED CIRCUITS/RADIATION HARDENING
Integrated circuit electromagnetic susceptibility investigation. Phase III. IC susceptibility handbook-draft 2, 3:26835 (AD-A-043777)
INTERMEDIATE BOSONS/COUPLING
Can couplings of charged heavy leptons to the W^0 be measured, 3:27174
INTERMEDIATE BOSONS/PARTICLE PRODUCTION
Single W-meson production in the scattering of hadrons in the Coulomb field of nuclei, 3:27234
INTERMEDIATE BTU GAS/COMBUSTION PROPERTIES
Development of combustion data to utilize low-Btu gases as industrial process fuels. Project 8985 monthly status report, November 1-November 30, 1977, 3:25712 (FE-2489-18)
INTERMEDIATE MASS NUCLEI/NUCLEAR STRUCTURE
Unified model studies of N = 84 and N = 80 nuclei, 3:27367 (IS-T-793)
INTERPLANETARY MAGNETIC FIELDS/TABLES
Solar-geophysical data number 396, August 1977. Part I. (Prompt Reports). Data for July 1977-June 1977, 3:27027 (PB-273617)
INTERSECTING BEAMS
See COLLIDING BEAMS
INTESTINES
See also SMALL INTESTINE
INTESTINES/ELECTRON MICROSCOPY
Procedural tip for intestine sections, 3:26958 (CONF-770504-)
INTESTINES/ENDOPLASMIC RETICULUM
Structural variations of the endoplasmic reticulum of the jejunal mucosal cell, 3:26978 (CONF-770504-)
INVERSE SCATTERING PROBLEM
(Problem of determining scattering potential from phase shifts.)
INVERSE SCATTERING PROBLEM/FINITE DIFFERENCE METHOD
Inverse scattering problem (finite-difference approach), 3:27311
INVERSE SCATTERING PROBLEM/MANY-DIMENSIONAL CALCULATIONS
Multidimensional method of the inverse scattering problem and duality equations for the Yang-Mills field, 3:27285
INVERSE SCATTERING PROBLEM/R MATRIX
Inverse scattering problem (finite-difference approach), 3:27311
INVERTEBRATES
See also PROTOZOA
INVERTEBRATES/ECOLOGY
Marine invertebrates in rocky intertidal communities, 3:26926 (TID-26712)
IODINE/REMOVAL
Long term performance of charcoal absorbers removing radioiodine in ventilation exhaust air. Final report, 3:26356 (EPRI-NP-534)
ION ACOUSTIC WAVES/DECAY INSTABILITY
Nonlinear stage of parametric interaction of waves in an active medium, 3:27585
ION ACOUSTIC WAVES/PARAMETRIC INSTABILITIES
Nonlinear stage of parametric interaction of waves in an active medium, 3:27585
ION ACOUSTIC WAVES/PLASMA SIMULATION
Quasi-neutral particle simulation model with application to ion wave propagation, 3:27570
ION ACOUSTIC WAVES/WAVE PROPAGATION
Diverging solitons and their transition to dispersive waves, 3:27574
ION BEAMS
See also ALPHA BEAMS
DEUTERON BEAMS
HELIUM 4 BEAMS
ION BEAMS/BEAM CURRENTS
Semiconductor measurement technology: some aspects of dose measurement for accurate ion implantation, 3:26825 (PB-269776)
ION BEAMS/PHOTON-ION COLLISIONS
Effect of an electric field upon resonances in the H^- ion, 3:27058
ION BEAMS/REVIEWS
Nuclear physics and investigations with multiply charged ions, 3:27316
ION BLOCKING
See ION CHANNELING
ION CHANNELING/ELECTRON CAPTURE
Theory of radiative electron capture by channeled ions, 3:27404
ION CYCLOTRON-RESONANCE HEATING
See ICR HEATING
ION DOSIMETRY
Semiconductor measurement technology: some aspects of dose measurement for accurate ion implantation, 3:26825 (PB-269776)

ION SOURCES
See also NEUTRAL BEAM SOURCES
PENNING ION SOURCES
Alternate approaches to D- beam production, 3:27659 (UCID-17672)
Source of low energy neutrals (1 to 4kV) for the production of negative ions, 3:27652 (CEA-CONF-3864)
ION SOURCES/BEAM EXTRACTION
Ion extraction from high electron temperature plasma and mass analysis, 3:27656 (IPPJ-DT-49)
Water cooled extraction grids, 3:27654 (EUR-5602)
ION SOURCES/BEAM TRANSPORT
Present status of negative ion acceleration and transportation from SP sources, 3:26799 (BNL-23652)
ION SOURCES/THERMIONIC EMISSION
Lithium ion source of thermionic emission type, 3:27657 (IPPJ-DT-51)
ION WAVES/CYCLOTRON INSTABILITY
Parametric dependence of the ion cyclotron instability in a two-energy-component system, 3:27545
ION-ATOM COLLISIONS/CHARGE EXCHANGE
Collisions of H^- ions and fast H^0 atoms in a Cs vapor target, 3:27068
Electron loss by atomic and molecular hydrogen in collisions with $^3He^{++}$ and $^4He^+$, 3:27076
ION-ATOM COLLISIONS/ENERGY-LEVEL TRANSITIONS
Radiative lifetimes of the low-lying levels of Na-like copper, 3:27080
ION-ATOM COLLISIONS/EXCITATION
Alignment of helium excited by thin carbon foils (50-500 keV He^+), 3:27075
ION-ION COLLISIONS/RECOMBINATION
Investigation of ion-ion recombination cross sections. Scientific report No. 2 (annual) 19 October 1975-18 October 1976, 3:27033 (AD-A-042185)
IONIZATION CHAMBERS/PERFORMANCE TESTING
Performance tests of the ORGDP radiation detection instruments (Compliance with Criticality Accident Alarm Systems), 3:26821 (Y/DD-215)
IONIZATION CHAMBERS/SENSITIVITY
Performance tests of the ORGDP radiation detection instruments (Compliance with Criticality Accident Alarm Systems), 3:26821 (Y/DD-215)
ION-MOLECULE COLLISIONS/CHARGE EXCHANGE
Electron loss by atomic and molecular hydrogen in collisions with $^3He^{++}$ and $^4He^+$, 3:27076
IONOSPHERE/DISTURBANCES
Effect of a cylindrically-symmetric ionospheric disturbance on elf propagation in the earth-ionosphere waveguide. Topical report, 3:27043 (AD-A-046237)
Project STRESS satellite communication test results. Final technical report, June 1976-March 1977, 3:27041 (AD-A-043873)
IONOSPHERE/ELECTRON DENSITY
Energization of polar-cusp electrons at the noon meridian. Progress report, 3:27037 (AD-A-042687)
IONOSPHERE/ION-ION COLLISIONS
Investigation of ion-ion recombination cross sections. Scientific report No. 2 (annual) 19 October 1975-18 October 1976, 3:27033 (AD-A-042185)
IONOSPHERE/MOLECULE COLLISIONS
Investigation of ion-ion recombination cross sections. Scientific report No. 2 (annual) 19 October 1975-18 October 1976, 3:27033 (AD-A-042185)
IONOSPHERE/SCINTILLATIONS
Ionospheric irregularities: optical support of HAES scintillation experiments. Final report, 15 December 1975-31 January 1977, 3:27038 (AD-A-043666)
IONOSPHERE/X-RAY SPECTRA
Hiris experiment-Chatanika radar results. Topical report, January-December 1976, 3:27032 (AD-A-042183)
IRIDIUM/ION EXCHANGE
Cation exchange of 53 elements in nitric acid, 3:26665 (LA-7083)
IRIDIUM FLUORIDES/MAGNETIC RESONANCE
Optical and zero field magnetic resonance spectroscopy of inorganic molecular solids. Final report, 1 June 1975-31 May 1977, 3:26645 (AD-A-043340)
IRIDIUM FLUORIDES/OPTICAL PROPERTIES
Optical and zero field magnetic resonance spectroscopy of inorganic molecular solids. Final report, 1 June 1975-31 May 1977, 3:26645 (AD-A-043340)
IRON/EMISSION SPECTROSCOPY
Determination of trace elements in soft, hard, and saline waters by the inductively coupled plasma, multi-element atomic emission spectroscopic (ICP-MAES) technique, 3:26664
IRON/HYPERFINE STRUCTURE
Self-consistent screening of a positive muon in a spin-polarized electron gas, 3:26604
IRON/INTERSTITIALS
Self-consistent screening of a positive muon in a spin-polarized electron gas, 3:26604
IRON/ION EXCHANGE
Cation exchange of 53 elements in nitric acid, 3:26665 (LA-7083)
IRON/PHOTOEMISSION
X-ray photoemission spectra of the valence bands of the 3d transition metals, Sc to Fe, 3:26608
IRON 56 TARGET/HELIUM 3 REACTIONS
$^{56}Fe(^3He,t)^{56}Co$ reaction, 3:27349
IRON 57/ENERGY-LEVEL TRANSITIONS
Test of time reversal invariance in ^{57}Fe, 3:27348
IRON 57/T INVARIANCE
Test of time reversal invariance in ^{57}Fe, 3:27348
IRON 60/ENERGY LEVELS
New isotopes of interest to explosive nucleosynthesis (Half-lives, branching ratios, J, π), 3:27355 (ANL-77-60)
IRON ALLOYS
See also INCONEL 600
STEELS
IRON ALLOYS/SPIN WAVES
High-temperature spin dynamics in an amorphous ferromagnet, 3:26603
IRON COMPOUNDS/CHEMICAL ANALYSIS
Moessbauer spectroscopy of iron compounds found in West Virginia coals, 3:25671
IRON-AIR BATTERIES/RESEARCH PROGRAMS
Federal battery program for transportation uses, 3:26485 (CONF-7606127-1)
ISABELLE STORAGE RINGS/BEAM DYNAMICS
ISABELLE machine glossary, 3:26809 (BNL-23538)
Prosaic use of stochastic cooling at ISABELLE, 3:26804 (BNL-23532)
ISABELLE STORAGE RINGS/MAINTENANCE
Time required to replace an ISABELLE ring magnet, 3:26808 (BNL-23536)
ISABELLE STORAGE RINGS/RF SYSTEMS
Choice of harmonic number for the ISABELLE accelerating rf system, 3:26807 (BNL-23535)
ISABELLE STORAGE RINGS/SHIELDING
Muon shield requirements for ISABELLE at 400 GeV/c, 3:26810 (BNL-23539)
ISABELLE STORAGE RINGS/SPARK CHAMBERS
Exotic 4π detector for ISABELLE, 3:26806 (BNL-23534)
ISABELLE STORAGE RINGS/SYNCHROTRON RADIATION
20 GeV e^+ x 400 GeV p: some synchrotron radiation considerations, 3:26805 (BNL-23533)
ISAR DEVICES/PLASMA PRODUCTION
Limits in the production of a low compressed high-beta plasma in the linear theta pinch Isar II, 3:27535
ISAR DEVICES/RESEARCH PROGRAMS
High beta stellarator, a toroidal confinement system, 3:27607
ISOBAR MODEL/NUCLEON-NUCLEON INTERACTIONS
Dynamics of N-N total cross sections at medium energies, 3:27227
ISOBUTYLENE
See 2-METHYLPROPENE
ISOELECTRONIC ATOMS/EXCITED STATES
Ordering of the excited-state energy levels of various atoms and their isoelectronic ions. II, 3:27053
ISOTOPE SEPARATION PLANTS/ECONOMICS
Cost analyses of uranium enrichment by laser isotope separation process, 3:25920
Optimum operating conditions for a laser uranium enrichment plant, 3:25918
Optimum operating conditions for a laser uranium enrichment plant, 3:25919
ITALY/VOLCANOES
Comparative temperature measurements on Mount Etna lavas: problems and techniques, 3:26088

J

J-3105 RESONANCES
See PSI-3105 RESONANCES
JAERI FUSION TORUS-2A
See JFT-2A TOKAMAK
JAPAN/ENERGY CONSUMPTION
International energy trends: 3rd quarter 1977 and recent trends, 3:26528 (NP-23033)
JAPAN/ENERGY POLICY
Japan's energy policy and role of LNG, 3:25850
JAPAN/GEOCHEMICAL SURVEYS
List of research and development of hot spring and geothermics, 3:26091 (NP-23043)

JAPAN/GEOPHYSICAL SURVEYS
List of research and development of hot spring and geothermics, 3:26091 (NP-23043)
JAPAN/GEOTHERMAL EXPLORATION
List of research and development of hot spring and geothermics, 3:26091 (NP-23043)
JAPAN/GEOTHERMAL FIELDS
Preliminary report of study on the gravimetric monitoring at the Takinoue geothermal area, Iwate Prefecture. Study on the geothermal system of geothermal area: the 4th report, 3:26095
JAPAN/HOT SPRINGS
Chemical components of hot springs in Nagano Prefecture, 3:26102
JAPAN/LMFBR TYPE REACTORS
Experience and future plan of fast reactor oxide fuels irradiation in Japan, 3:26301
Japanese development program for advanced LMFBR fuels, 3:26297
JAPAN/MINERAL SPRINGS
Tables of chemical analysis of mineral waters (1961-1966) from the Hot Spring Research Institute of Kanagawa Prefecture, 3:26104
JAPAN/VOLCANOES
Identification of eruption clouds with the Landsat satellites, 3:26089
JAPAN NUCLEAR SAFETY RESEARCH REACTOR
See NSRR REACTOR
JAPAN RESEARCH REACTOR-4
See JRR-4 REACTOR
JEJUNUM
See SMALL INTESTINE
JET ENGINE FUELS/CHEMICAL PROPERTIES
Determination of thermal stability of jet fuels under dynamic conditions, 3:25816
JET ENGINE FUELS/CORROSIVE EFFECTS
Mechanism of action on rubber by products from thermal oxidation of hydrotreated fuels, 3:25787
JET ENGINE FUELS/FIRE HAZARDS
Full-scale aircraft crash tests of modified jet fuel. Final report, July 1972-May 1974, 3:25796 (AD-A-043843)
JET ENGINE FUELS/STABILITY
Determination of thermal stability of jet fuels under dynamic conditions, 3:25816
JET MODEL/QUANTUM NUMBERS
Retention of quantum numbers by quark and multiquark jets, 3:27159
JET TOKAMAK/MECHANICAL STRUCTURES
Three-dimensional calculations for the JET mechanical structure, 3:27694 (EUR-5602)
JET TOKAMAK/PLASMA INSTABILITY
Local, ideal and resistive stability in tokamaks with non-circular cross-section, 3:27557
JET TOKAMAK/POWER SUPPLIES
JET power supply comprehensive system, 3:27646 (EUR-5602)
JETS/INSTABILITY
Use of one-dimensional Cosserat theory to study instability in a viscous liquid jet, 3:27088
JETS/USES
Performance of a high-pressure pulsed water-jet device for fracturing concrete pavement (For maintenance of underground utilities), 3:26704 (CONF-780409-1)
JFT-2 TOKAMAK/HYBRID RESONANCE
Numerical studies of lower hybrid wave propagation in JFT-2, 3:27566 (JAERI-M-6902)
JFT-2 TOKAMAK/NEUTRAL ATOM BEAM INJECTION
Composition of neutral beam for heating JFT-2 plasma, 3:27434 (JAERI-M-6990)
JFT-2A TOKAMAK/LIMITERS
Diagnostics of a scrape-off layer plasma, 3:27613 (JAERI-M-6971)
JFT-2A TOKAMAK/PLASMA DIAGNOSTICS
Electrostatic diagnostics of JFT-2a (DIVA), 3:27467 (JAERI-M-6861)
JRR-4 REACTOR/REACTOR OPERATION
Neutron radiography experiments at JRR-4, (2). Neutron radiography of simulated mixed-oxide fuels, 3:26390
JT-60 TOKAMAK/BELLOWS
Stress analysis of the bellows and its connection with a thick ring of the vacuum vessel, 3:27702 (JAERI-M-6822)
JT-60 TOKAMAK/ELECTRIC CURRENTS
Effect of plasma minor-radius expansion in the current build-up phase of a large tokamak, 3:27615 (JAERI-M-7014)
JT-60 TOKAMAK/LIMITERS
Heat analysis of the magnetic limiter plate for JT-60, 3:27614 (JAERI-M-7013)
JT-60 TOKAMAK/STRESS ANALYSIS
Stress analysis of the bellows and its connection with a thick ring of the vacuum vessel, 3:27702 (JAERI-M-6822)

K

K01
See KAONS NEUTRAL SHORT-LIVED
K*RESONANCES/MASS SPECTRA
Progress in K spectroscopy (Review, harmonic oscillator quark model), 3:27217 (SLAC-PUB-1980)
KAON MINUS-NEUTRON INTERACTIONS/CHARGE-EXCHANGE INTERACTIONS
Comparison of K^{+-} N charge-exchange reactions at 8.5 and 13 GeV/c, 3:27138
KAON MINUS-PROTON INTERACTIONS/CHARGE-EXCHANGE INTERACTIONS
Comparison of K^{+-} N charge-exchange reactions at 8.5 and 13 GeV/c, 3:27138
KAON MINUS-PROTON INTERACTIONS/MULTIPLE PRODUCTION
Search for Ξ^* production in K^-p interactions at 2.87 GeV/c, 3:27140
KAON PLUS-NEUTRON INTERACTIONS/CHARGE-EXCHANGE INTERACTIONS
Comparison of K^{+-} N charge-exchange reactions at 8.5 and 13 GeV/c, 3:27138
KAON PLUS-PROTON INTERACTIONS/CHARGE-EXCHANGE INTERACTIONS
Comparison of K^{+-} N charge-exchange reactions at 8.5 and 13 GeV/c, 3:27138
KAONS/LEPTONIC DECAY
Quantum mechanics in particle physics, 3:27202
KAONS NEUTRAL SHORT-LIVED/PARTICLE PRODUCTION
Inclusive production of neutral strange particles in 250-GeV/c π^- p interactions (Cross sections), 3:27145
KERNKRAFTWERK LINGEN
See LINGEN REACTOR
KERNKRAFTWERK PHILIPPSBURG-1
See PHILIPPSBURG-1 REACTOR
KERNKRAFTWERK PHILIPPSBURG-2
See PHILIPPSBURG-2 REACTOR
KEROGEN/CHEMICAL ANALYSIS
Prospects for carbon-13 nuclear magnetic resonance analysis of solid fossil-fuel materials, 3:25668
KEROGEN/STRUCTURAL CHEMICAL ANALYSIS
Nature of straight-chain aliphatic structures in Green River kerogen, 3:25891
KETENES/BIOLOGICAL EFFECTS
Photorepair of uv damage to DNA: purification and properties of DNA photolyase (the DNA-photoreactivating enzyme). Progress and final reports, August 1, 1976-July 31, 1977, 3:26948 (ORO-3630-26)
KETONES
See also ACETONE
KETONES/SYNTHESIS
Bayer process for the manufacture of maleic anhydride from butenes and as a by-product of the phthalic anhydride production, 3:25786
KILAUEA VOLCANO/GEOCHEMICAL SURVEYS
Geochemistry of the Hawaii geothermal well, HGP-A (abstract), 3:26100
KILAUEA VOLCANO/GEOCHEMISTRY
Geology and chemistry of Hawaii geothermal project well-A, Kilauea Volcano (abstract), 3:26086
KILAUEA VOLCANO/GEOLOGY
Geology and chemistry of Hawaii geothermal project well-A, Kilauea Volcano (abstract), 3:26086
KILAUEA VOLCANO/GEOPHYSICAL SURVEYS
Evaluation of geophysical techniques for geothermal exploration on an active basaltic volcano (abstract), 3:26093
KILAUEA VOLCANO/SEISMIC SURVEYS
Evaluation of geophysical techniques for geothermal exploration on an active basaltic volcano (abstract), 3:26093
KILAUEA VOLCANO/WELL DRILLING
Geochemistry of the Hawaii geothermal well, HGP-A (abstract), 3:26100
Geology and chemistry of Hawaii geothermal project well-A, Kilauea Volcano (abstract), 3:26086
KINETICS EQUATION (REACTOR)
See REACTOR KINETICS EQUATIONS
KINK INSTABILITY/MAGNETIC FIELD CONFIGURATIONS
Moment equations treatment of the reconnecting mode, 3:27553
KKP-1 PHILIPPSBURG REACTOR
See PHILIPPSBURG-1 REACTOR
KKP-2 PHILIPPSBURG REACTOR
See PHILIPPSBURG-2 REACTOR
KLYSTRONS/STABILIZATION
Laser as a means of transferring a standard frequency into the submillimeter range, 3:26757
KNOCK-ON ELECTRONS
See ELECTRONS

KOEBERG-1 REACTOR
Koeberg's cooling water marine basin next on agenda, 3:26241
KOEBERG-2 REACTOR
Koeberg's cooling water marine basin next on agenda, 3:26241
KRYPTON 86 REACTIONS/PRECOMPOUND-NUCLEUS EMISSION
Pre-equilibrium α emission in reactions of 724-MeV ^{86}Kr with Au: A coincidence study of direct and evaporation mechanisms, 3:27379
KWL REACTOR
See LINGEN REACTOR

L

LABELLED COMPOUNDS
See also RADIOPHARMACEUTICALS
LABELLED COMPOUNDS/CHEMICAL PREPARATION
Biomedical research and application utilizing cyclotron produced radionuclides. Progress report, January 1 1977-December 31, 1977, 3:26971 (COO/4268-1)
LAGRANGIAN FIELD THEORY
Unitary unified field theories, 3:27309
LAGRANGIAN FIELD THEORY/CONFORMAL INVARIANCE
Conformal-invariant behavior of four-point theories in the ultraviolet limit, 3:27287
LAGRANGIAN FIELD THEORY/SCALE INVARIANCE
Conformal-invariant behavior of four-point theories in the ultraviolet limit, 3:27287
LAGRANGIAN FIELD THEORY/ULTRAVIOLET DIVERGENCES
Conformal-invariant behavior of four-point theories in the ultraviolet limit, 3:27287
LAKES/HEAT FLOW
In situ thermal conductivity measurements for heat flow determinations in marine and lacustrine environments (abstract), 3:26094
LAMBDA NEUTRAL
See LAMBDA PARTICLES
LAMBDA PARTICLES/LEPTONIC DECAY
Measurement of the angular correlation parameters in the β decay of polarized Λ hyperons (Axial-vector-to-vector from factor spin-asymmetry parameters, correlations), 3:27117
LAMBDA PARTICLES/PARTICLE PRODUCTION
Inclusive baryon production in e^+e^- annihilation, 3:27103
Inclusive production of neutral strange particles in 250-GeV/c π^-p interactions (Cross sections), 3:27145
Inclusive production of Λ^0 hyperons by 300-GeV protons: A dependence, 3:27129
LAND POLLUTION
See also ACID MINE DRAINAGE
LAND POLLUTION/PARTICLE RESUSPENSION
Wind effected redistribution of surface contamination. Final report, September 1972-August 1976, 3:26880 (ORO-4394-4)
LAND RECLAMATION
Strip mining. Volume 2. 1976-October 1977 (citations from the NTIS data base). Report for 1976-Oct 77, 3:26919 (NTIS/PS-77/0951)
LAND USE/PLANNING
GMAPS user's manual, 3:26917 (LA-6975-M)
LANDAU DAMPING/ELECTRON-ELECTRON COLLISIONS
Electron Landau damping and electron collisions, 3:27571
LANTHANIDES
See RARE EARTHS
LASER FUSION REACTORS
Power lasers for thermonuclear fusion, 3:27688
Summary of inertial confinement, 3:27685
LASER FUSION REACTORS/BREEDING BLANKETS
Comparison of liquid ISSECs; Li, Pb, and Pb_4Li for use in laser fusion reactors, 3:27620 (UWFDM-208)
LASER FUSION REACTORS/COMPARATIVE EVALUATIONS
Laser driven fusion fission hybrids, 3:27681 (UCRL-79653(Rev.1))
LASER FUSION REACTORS/FIRST WALL
Comparison of liquid ISSECs; Li, Pb, and Pb_4Li for use in laser fusion reactors, 3:27620 (UWFDM-208)
Effect of a liquid ISSEC on radiation damage parameters in laser fusion reactor first walls, 3:27619 (UWFDM-205)
Research on the wetted first wall concept for future laser fusion reactors. Final report No. 2, February 1, 1976-August 31, 1977, 3:27672 (UCRL-13677-3)
LASER FUSION REACTORS/LASER RADIATION
Calculations of the laserlight-transmission in laser-fusion-reactors at various densities and density-profiles, 3:27668 (Juel-1399)
LASER FUSION REACTORS/LEADING ABSTRACT
Energy and technology review, 3:27673 (UCRL-52000-77-8)
LASER FUSION REACTORS/PHYSICAL RADIATION EFFECTS
Effect of a liquid ISSEC on radiation damage parameters in laser fusion reactor first walls, 3:27619 (UWFDM-205)
LASER FUSION REACTORS/PLASMA DIAGNOSTICS
Diagnosis of laser fusion targets, 3:27677 (UCRL-52000-77-8)
LASER FUSION REACTORS/PLASMA EXPANSION
High energy ion expansion in laser-plasma interactions, 3:27669 (NRL-MR-3669)
LASER FUSION REACTORS/RESEARCH PROGRAMS
Laser fusion program overview, 3:27674 (UCRL-52000-77-8)
LASER FUSION REACTORS/SHIELDING
Comparison of liquid ISSECs; Li, Pb, and Pb_4Li for use in laser fusion reactors, 3:27620 (UWFDM-208)
Effect of a liquid ISSEC on radiation damage parameters in laser fusion reactor first walls, 3:27619 (UWFDM-205)
LASER FUSION REACTORS/THERMONUCLEAR FUELS
Plasma polymerization coating of D-T filled glass shells for laser fusion targets, 3:27682 (UCRL-80162)
LASER FUSION REACTORS/TRANSPORT THEORY
Transport of long-mean-free-path electrons in laser-fusion plasmas, 3:27683
LASER FUSION REACTORS/USES
Applications of laser fusion, 3:27679 (UCRL-52000-77-8)
LASER IMPLOSIONS/PERTURBATION THEORY
Fluid dynamic stability studies of laser imploded spherical shells, 3:27667 (CEA-CONF-3886)
LASER IMPLOSIONS/PLASMA DENSITY
Direct measurement of compression of laser-imploded targets using x-ray spectroscopy, 3:27474
LASER MIRRORS/PHYSICAL RADIATION EFFECTS
Absorption of electromagnetic radiation in the transparent regime of solids. Final report, 14 October 1974-13 October 1975, 3:26658 (AD-A-042226)
LASER RADIATION
Research on the ocular effects of laser radiation. Final report, 16 February 1975-30 November 1976, 3:26999 (AD-A-043457)
LASER RADIATION/ABSORPTION
Absorption of electromagnetic radiation in the transparent regime of solids. Final report, 14 October 1974-13 October 1975, 3:26658 (AD-A-042226)
LASER RADIATION/PHOTON-ION COLLISIONS
Effect of an electric field upon resonances in the H^- ion, 3:27058
LASER RADIATION/RADIATION PRESSURE
Ponderomotive force in a hydrodynamic simulation code, 3:27093 (UCRL-79860)
LASER-PRODUCED PLASMA
High-temperature high-quality deuterium plasma production by laser beam(s) by means of on-line computer control technique, 3:27427 (EUR-5602)
LASER-PRODUCED PLASMA/BACKSCATTERING
Non-linear interaction of intense CO_2 radiation with dense plasma, 3:27686
LASER-PRODUCED PLASMA/BRILLOUIN EFFECT
Brillouin scatter in laser-produced plasmas, 3:27447
Observations of stimulated Brillouin backscattering from a magnetically confined plasma, 3:27568
LASER-PRODUCED PLASMA/ENERGY ABSORPTION
Brillouin scatter in laser-produced plasmas, 3:27447
Interaction of 1.06-μm laser radiation with planar targets, 3:27448
LASER-PRODUCED PLASMA/PARAMETRIC INSTABILITIES
Measurements of the parametric decay of CO_2-laser radiation into plasma waves at quarter-critical density using ruby-laser Thomson scattering, 3:27440
LASER-PRODUCED PLASMA/PLASMA ACCELERATION
Fast expansions of laser-heated plasmas, 3:27532
LASER-PRODUCED PLASMA/PLASMA DIAGNOSTICS
Laser-produced dense plasma diagnostics based on spectra of hydrogen-like and helium-like multicharged ions, 3:27692
Measurements of the parametric decay of CO_2-laser radiation into plasma waves at quarter-critical density using ruby-laser Thomson scattering, 3:27440
Micro-Fresnel zone plates for coded imaging applications, 3:27473
LASER-PRODUCED PLASMA/PLASMA EXPANSION
Fast expansions of laser-heated plasmas, 3:27532
High-energy ion expansion in laser-plasma interactions, 3:27442
Stationary model of the 'corona' of spherical laser targets, 3:27690
LASER-PRODUCED PLASMA/PLASMA SIMULATION
High-energy ion expansion in laser-plasma interactions, 3:27442
LASER-PRODUCED PLASMA/TRANSMISSION
Calculations of the laserlight-transmission in laser-fusion-reactors at various densities and density-profiles, 3:27668 (Juel-1399)
LASER-RADIATION HEATING/BRILLOUIN EFFECT
Brillouin scatter in laser-produced plasmas, 3:27447

LASER-RADIATION HEATING/ENERGY ABSORPTION
Electromagnetic structure resonances in inhomogeneous plasma layers, 3:27441
LASER-RADIATION HEATING/ENERGY LOSSES
Brillouin scatter in laser-produced plasmas, 3:27447
LASER-RADIATION HEATING/ION EMISSION
Production of fast ions in laser-heated plasmas, 3:27459
LASER-RADIATION HEATING/PARAMETRIC INSTABILITIES
Measurements of the parametric decay of CO_2-laser radiation into plasma waves at quarter-critical density using ruby-laser Thomson scattering, 3:27440
LASER-RADIATION HEATING/PLASMA SIMULATION
Properties of resonantly heated electron distributions, 3:27444
LASER-RADIATION HEATING/RESONANCE ABSORPTION
Properties of resonantly heated electron distributions, 3:27444
LASER-RADIATION HEATING/X-RAY SPECTRA
Fast-electron production in laser-heated plasmas, 3:27477
LASERS
See also CARBON DIOXIDE LASERS
CARBON MONOXIDE LASERS
CHEMICAL LASERS
DYE LASERS
GAS LASERS
NEODYMIUM LASERS
SEMICONDUCTOR LASERS
SOLID STATE LASERS
LASERS/COLLIDING BEAMS
Technical progress report, 1 July 1976-30 November 1977 (Summaries of research activities at California Institute of Technology), 3:27064 (CALT-767P4-161)
LASERS/OPERATION
Operation of a traveling-wave laser with periodically varying cavity parameters. Fast rotation, 3:26762
LASERS/OPTICAL PUMPING
Effect of discharge buildup in flash lamps on the efficiency of laser pumping, 3:26754
K-RB laser pump lamp. Final technical report Nov 73-Feb 75, 3:26734 (AD-B-009019)
LASERS/PHOTOCHEMISTRY
Technical progress report, 1 July 1976-30 November 1977 (Summaries of research activities at California Institute of Technology), 3:27064 (CALT-767P4-161)
LASERS/Q-SWITCHING
Differential electro-optical shutter, 3:26752
LASERS/RESEARCH PROGRAMS
Tunable optical sources. Final report 1 Jul 74-30 Jun 77, 3:26732 (AD-A-046004)
LASERS/STABILITY
Feedback and acousto optic isolation effects on laser stability. Final report, June 1975-June 1976, 3:26721 (AD-A-042346)
LASERS/TRAVELLING WAVES
Competition of oppositely traveling waves in a single-isotope ring laser with anisotropic cavity, 3:26747
LASERS/USES
Remote sensing using tunable lasers, 3:26870 (AED-Conf-77-165-002)
LASERS/WINDOWS
Ir window studies. Final report, 1 September 1975-1 September 1976, 3:26725 (AD-A-042561)
Temperature, stress and optical phase difference for a window transmitting a cw laser beam. Research report, 3:26726 (AD-A-042671)
LASL
(Los Alamos Scientific Laboratory.)
LASL/RADIATION MONITORING
Integrated minicomputer alpha analysis system (Measurements of alpha activities of particulates), 3:26888 (LA-UR-77-2968)
LASL/RESEARCH PROGRAMS
Solar energy research, 3:26049 (LA-6807-PR)
LATTICES (REACTOR)
See REACTOR LATTICES
LAVA/CHEMICAL COMPOSITION
Rare earth and other trace elements in historic Azorean lavas, 3:27009
LAVA/TEMPERATURE MEASUREMENT
Comparative temperature measurements on Mount Etna lavas: problems and techniques, 3:26088
LAWRENCE LIVERMORE LABORATORY/RESEARCH PROGRAMS
Energy and Resource Planning Group FY 1977 annual report (Use of LLL Energy Model (LLLEM)), 3:26495 (UCRL-50029-77)
LEAD/COSTER-KRONIG TRANSITIONS
L shell fluorescence yields and Coster-Kronig transition probabilities using radioactive sources. Final report, 3:27056 (AD-A-042228)
LEAD/EMISSION SPECTROSCOPY
Determination of trace elements in soft, hard, and saline waters by the inductively coupled plasma, multi-element atomic emission spectroscopic (ICP-MAES) technique, 3:26664
LEAD/ENVIRONMENTAL TRANSPORT
Corrections and revisions to the FORTRAN IV version of the Wisconsin Hydrologic Transport Model, 3:27003 (ORNL/NSF/EATC-29)
LEAD/HEAVY ION REACTIONS
Proton and pion spectra at large angles in relativistic heavy-ion collisions (800 MeV/N), 3:27332 (LBL-670)
LEAD/ION EXCHANGE
Cation exchange of 53 elements in nitric acid, 3:26665 (LA-7083)
LEAD/QUANTITATIVE CHEMICAL ANALYSIS
Fate of trace and minor constituents of coal during gasification. Final task report, 3:25641 (PB-270913)
LEAD/SUPERCONDUCTIVITY
Oscillations of properties of thin superconducting films with varying coating thickness, 3:26624
LEAD/X-RAY SPECTRA
L shell fluorescence yields and Coster-Kronig transition probabilities using radioactive sources. Final report, 3:27056 (AD-A-042228)
LEAD 204/ENERGY LEVELS
Electron scattering from ^{204}Pb, ^{206}Pb, ^{207}Pb, ^{208}Pb (Bates Linac) (57.5 to 258 MeV, cross sections, J,π), 3:27377 (ORO-4043-37)
LEAD 204 TARGET/ELECTRON REACTIONS
Electron scattering from ^{204}Pb, ^{206}Pb, ^{207}Pb, ^{208}Pb (Bates Linac) (57.5 to 258 MeV, cross sections, J,π), 3:27377 (ORO-4043-37)
LEAD 206/ENERGY LEVELS
Electron scattering from ^{204}Pb, ^{206}Pb, ^{207}Pb, ^{208}Pb (Bates Linac) (57.5 to 258 MeV, cross sections, J,π), 3:27377 (ORO-4043-37)
LEAD 206 TARGET/ELECTRON REACTIONS
Electron scattering from ^{204}Pb, ^{206}Pb, ^{207}Pb, ^{208}Pb (Bates Linac) (57.5 to 258 MeV, cross sections, J,π), 3:27377 (ORO-4043-37)
LEAD 207/ENERGY LEVELS
Electron scattering from ^{204}Pb, ^{206}Pb, ^{207}Pb, ^{208}Pb (Bates Linac) (57.5 to 258 MeV, cross sections, J,π), 3:27377 (ORO-4043-37)
LEAD 207 TARGET/ELECTRON REACTIONS
Electron scattering from ^{204}Pb, ^{206}Pb, ^{207}Pb, ^{208}Pb (Bates Linac) (57.5 to 258 MeV, cross sections, J,π), 3:27377 (ORO-4043-37)
LEAD 207 TARGET/**NEUTRON REACTIONS**
Coherent dissociation of neutrons on nuclei at 100-300 GeV/c, 3:27123
Inclusive charged-particle production in neutron-nucleus collisions, 3:27121
LEAD 207 TARGET/**PHOTONUCLEAR REACTIONS**
Pre-equilibrium particle decay in the photonuclear reactions, 3:27327
LEAD 207 TARGET/**PROTON REACTIONS**
Inclusive production of Λ^0 hyperons by 300-GeV protons: A dependence, 3:27129
LEAD 208/ENERGY LEVELS
Electron scattering from ^{204}Pb, ^{206}Pb, ^{207}Pb, ^{208}Pb (Bates Linac) (57.5 to 258 MeV, cross sections, J,π), 3:27377 (ORO-4043-37)
LEAD 208/**GIANT RESONANCE**
Investigation of giant multipole resonances in medium and heavy nuclei by inelastic electron scattering. Final technical report, 15 October 1974-31 October 1976, 3:27356 (AD-A-042298)
LEAD 208/**HYPERNUCLEI**
Possibility of charmed hypernuclei, 3:27228
LEAD 208 TARGET/CARBON 12 REACTIONS
Folding model description of heavy ion inelastic scattering, 3:27328
LEAD 208 TARGET/**ELECTRON REACTIONS**
Electron scattering from ^{204}Pb, ^{206}Pb, ^{207}Pb, ^{208}Pb (Bates Linac) (57.5 to 258 MeV, cross sections, J,π), 3:27377 (ORO-4043-37)
Investigation of giant multipole resonances in medium and heavy nuclei by inelastic electron scattering. Final technical report, 15 October 1974-31 October 1976, 3:27356 (AD-A-042298)
LEAD 208 TARGET/**PHOTONUCLEAR REACTIONS**
Distribution of M1 strength in ^{208}Pb (7.5 to 10 MeV excitation, polarization and analyzing power), 3:27376 (ANL-77-60)
LEAD 208 TARGET/**PION MINUS REACTIONS**
Coincidence measurements of quasielastic pion scattering by ^{27}Al and ^{208}Pb, 3:27342
LEAD 208 TARGET/**PION PLUS REACTIONS**
Coincidence measurements of quasielastic pion scattering by ^{27}Al and ^{208}Pb, 3:27342
Properties of inclusive (π^+,π^0) reactions in nuclei, 3:27334
LEAD 208 TARGET/**PROTON REACTIONS**
Elastic scattering of 1-GeV protons by nuclei, 3:27127
LEAD 210/ENVIRONMENTAL TRANSPORT
Distribution of some chemical elements between dissolved and particulate phases in the ocean. Period covered: August 1, 1976-October 31, 1977 (Natural ^{210}Pb and ^{210}Po tracers), 3:26930 (COO-3566-19)

LEAD OXIDES/POINT POLLUTANT SOURCES
Source assessment: pressed and blown glass manufacturing plants. Final task report Sep 75-Jan 77, 3:26882 (PB-273788)
LEAD-ACID BATTERIES/DESIGN
State-of-the-art lead-acid vehicle batteries, 3:26484 (ANL-K-77-3639-1)
LEAD-ACID BATTERIES/ELECTRIC CONTROLLERS
Protection of lead accumulators against low discharge, 3:26493
LEAD-ACID BATTERIES/ELECTRIC UTILITIES
Economic assessment of the utilization of lead-acid batteries in electric utility systems. Final report, 3:26522 (HCP/T2857-1)
LEAD-ACID BATTERIES/RESEARCH PROGRAMS
Federal battery program for transportation uses, 3:26485 (CONF-7606127-1)
LEAD-ACID BATTERIES/SPECIFICATIONS
Batteries for utility load leveling, 3:26486
LEAD-ACID BATTERIES/TEST FACILITIES
Environmental assessment: Battery Energy Storage Test (BEST) Facility, Hillsborough, Somerset County, New Jersey, 3:26489 (DOE/EA-0001)
LEAD-ACID BATTERIES/USES
Economic assessment of the utilization of lead-acid batteries in electric utility systems. Final report, 3:26522 (HCP/T2857-1)
LEASES/COMPUTER GRAPHICS
Energy systems and statistics, 3:26505 (LA-6807-PR)
LEAVES/CONTAMINATION
Estimated inventory of plutonium and uranium radionuclides for vegetation in aged fallout areas, 3:26913 (NVO-171)
LEPTON REACTIONS
See also ELECTRON REACTIONS
MUON REACTIONS
NEUTRINO REACTIONS
LEPTON REACTIONS/DEEP INELASTIC SCATTERING
Relativistic interactions in nuclei and the approach to scaling in deep inelastic scattering, 3:27390 (SLAC-203)
LEPTON-HADRON INTERACTIONS/QUARK MODEL
Retention of quantum numbers by quark and multiquark jets, 3:27159
LEPTON-PROTON INTERACTIONS/FINAL-STATE INTERACTIONS
Relativistic interactions in nuclei and the approach to scaling in deep inelastic scattering, 3:27390 (SLAC-203)
LEPTON-PROTON INTERACTIONS/SCALE INVARIANCE
Relativistic interactions in nuclei and the approach to scaling in deep inelastic scattering, 3:27390 (SLAC-203)
LEPTONS
See also ELECTRONS
HEAVY LEPTONS
MUONS
NEUTRINOS
LEPTONS/MASS SPECTRA
Three generations of quarks and leptons (Review, Weinberg-Salam gauge model, Higgs particles), 3:27240 (SLAC-PUB-1974)
LEPTONS/PAIR PRODUCTION
Retention of quantum numbers by quark and multiquark jets, 3:27159
LEPTONS/PARTICLE INTERACTIONS
Three generations of quarks and leptons (Review, Weinberg-Salam gauge model, Higgs particles), 3:27240 (SLAC-PUB-1974)
LEPTONS/PARTICLE PRODUCTION
e^+e^- annihilation into hadrons at SPEAR (Review, total cross sections, charged multiplicity), 3:27098 (SLAC-PUB-1624)
LEPTONS/WEAK INTERACTIONS
Three generations of quarks and leptons (Review, Weinberg-Salam gauge model, Higgs particles), 3:27240 (SLAC-PUB-1974)
LEUKEMIA VIRUS/ULTRASTRUCTURAL CHANGES
Ultrastructural studies on Friend leukemia virus, 3:26974 (CONF-770504-)
LEVEL INDICATORS/DESIGN
Displacement technique for calibration for special nuclear material tankage volumes, 3:26840 (RFP-2627)
LEWIS BASES/BINDING ENERGY
Binding of Li^+ to Lewis bases in the gas phase. Reversals in methyl substituent effects for different reference acids, 3:26673
LIFE SPAN/BIOLOGICAL RADIATION EFFECTS
Competing risk model for reduction in life expectancy from radiogenic latent cancer (Radiation exposure as result of nuclear reactor accidents), 3:26985 (SAND-77-1352C)
LIGHT
See VISIBLE RADIATION
LIGHT CONE/QUANTUM FIELD THEORY
Demise of light cone field theory, 3:27291
LIGHT NUCLEI/NUCLEAR REACTIONS
Relativistic interactions in nuclei and the approach to scaling in deep inelastic scattering (Cross sections, nucleon-nucleon force), 3:27390 (SLAC-203)
LIGHTING SYSTEMS/EFFICIENCY
Recommendations for enforcing and administering lighting-efficiency standards in existing public buildings in New York State. Final report, 3:26509 (HCP/M1223-1)
LIGHTING SYSTEMS/HAZARDS
Methods of protection of obviate hazardous sparkaing in explosion-proof luminaries with fluorescent lamps, 3:25725
LIGHTING SYSTEMS/STANDARDS
Recommendations for enforcing and administering lighting-efficiency standards in existing public buildings in New York State. Final report, 3:26509 (HCP/M1223-1)
LIGNIN/ANAEROBIC DIGESTION
Heat treatment of organics for increasing anaerobic biodegradability. Quarterly progress report, March 1, 1977-May 31, 1977, 3:26007 (COO/2991-19)
LIGNITE/CHEMICAL ANALYSIS
Fate of trace and minor constituents of coal during gasification. Final task report, 3:25641 (PB-270913)
Prospects for carbon-13 nuclear magnetic resonance analysis of solid fossil-fuel materials, 3:25668
LIGNITE/CHEMICAL COMPOSITION
Coal Creek Station steam generators, 3:26130 (GFERC/IC-77/1)
Origin of certain heterocyclic compounds from depolymerization of lignite, 3:25669
LIGNITE/COMBUSTION
Coal Creek Station steam generators, 3:26130 (GFERC/IC-77/1)
LIGNITE/DEPOLYMERIZATION
Origin of certain heterocyclic compounds from depolymerization of lignite, 3:25669
LIGNITE/HYDROGENATION
Basic studies of coal pyrolysis and hydrogasification. Quarterly progress report, July 1, 1977-September 30, 1977, 3:25619 (FE-MIT-2295T26-3)
LIGNITE/PYROLYSIS
Basic studies of coal pyrolysis and hydrogasification. Quarterly progress report, July 1, 1977-September 30, 1977, 3:25619 (FE-MIT-2295T26-3)
Preparation of a coal conversion systems technical data book. Project 8979 quarterly report, May 1-July 31, 1977, 3:25633 (FE-2286-20)
LIMITERS
Tokamak boundary in contact with a limiter, 3:27630
LIMITERS/HEAT TRANSFER
Heat analysis of the magnetic limiter plate for JT-60, 3:27614 (JAERI-M-7013)
LIMITERS/PERFORMANCE
Description of the fast moving limiter used with T.F.R., 3:27612 (EUR-CEA-FC-893)
Diagnostics of a scrape-off layer plasma, 3:27613 (JAERI-M-6971)
LINACS
See LINEAR ACCELERATORS
LINEAR ACCELERATORS/DESIGN
Physics Division annual review, 1 April 1976-31 March 1977 (ANL), 3:27312 (ANL-77-60)
LINEAR ACCELERATORS/RESEARCH PROGRAMS
Ohio University tandem Van de Graaff accelerator. Final report, 3:26788 (COO-1717-9)
LINEAR PINCH DEVICES/ENERGY LOSSES
Endloss from a slender high-beta plasma column contained in a linear solenoid, 3:27466
LINEAR PINCH DEVICES/MAGNETIC FIELD REVERSAL
Reversal of the toroidal magnetic field in pinches, 3:27631 (CLM-R-165)
LINEAR THETA PINCH DEVICES/ADIABATIC COMPRESSION HEATING
Pure-fusion and fusion-fission reactor applications of high-density linear confinement systems, 3:27454
LINEAR THETA PINCH DEVICES/LASER-RADIATION HEATING
Pure-fusion and fusion-fission reactor applications of high-density linear confinement systems, 3:27454
LINEAR THETA PINCH DEVICES/PLASMA HEATING
Heating a dense theta-pinch plasma with strong fast-rising magnetic fields, 3:27460
LINEAR Z PINCH DEVICES/ACCELERATION
Dynamics of a non-cylindrical Z-pinch and the particle acceleration mechanism, 3:27517
LINEAR Z PINCH DEVICES/DESIGN
Conceptual fusion reactor based on the high-plasma-density Z-pinch, 3:27604
LINERS/FABRICATION
Improvement of the mechanical reliability of monolithic refractory linings for coal gasification process vessels. Bimonthly letter progress report, October-November 1977, 3:25630 (FE-2218-15)
LINERS/TESTING
Improvement of the mechanical reliability of monolithic refractory linings for coal gasification process vessels.

Bimonthly letter progress report, October-November 1977, 3:25630 (FE-2218-15)
LINGEN REACTOR/CONSTRUCTION
Lingen nuclear power plant: construction and operation, 3:26222
LINGEN REACTOR/REACTOR OPERATION
Lingen nuclear power plant: construction and operation, 3:26222
LIPPMANN-SCHWINGER EQUATION/DELTA FUNCTION
Problem of several delta-shell potentials in the Lippmann-Schwinger formulation, 3:27407
LIQUEFIED NATURAL GAS/CONTAINMENT
New Invar membrane containment system for construction of LNG carriers, 3:25880
LIQUEFIED NATURAL GAS/CONTRACTS
Legal problems of long term LNG contracts, 3:25863
LIQUEFIED NATURAL GAS/COST
Prospects of LNG export and its limitations, 3:25847
LIQUEFIED NATURAL GAS/DEMAND FACTORS
Japan's energy policy and role of LNG, 3:25850
LIQUEFIED NATURAL GAS/DENSITY
Densities of LNG for custody transfer, 3:25881
LIQUEFIED NATURAL GAS/ENERGY RECOVERY
Electricity generation by utilization of LNG-cold, 3:25839
LIQUEFIED NATURAL GAS/FINANCING
Contribution of the Export-Import Bank of Japan to Japanese LNG projects, 3:25854
Financing aspects of LNG trade, 3:25853
Project financing of LNG trade, 3:25855
LIQUEFIED NATURAL GAS/GASIFICATION
Electricity generation by utilization of LNG-cold, 3:25839
Nitrogen gas turbines for LNG regasification, 3:25840
LIQUEFIED NATURAL GAS/LAND TRANSPORT
LNG transportation by road tank trailers, 3:25873
LIQUEFIED NATURAL GAS/LEGAL ASPECTS
Legal problems of long term LNG contracts, 3:25863
LIQUEFIED NATURAL GAS/LOSSES
Tests at the FOS terminal on the LNG behavior in the big tanks, 3:25888
Ultra low-temperature LNG compressors, 3:25889
LIQUEFIED NATURAL GAS/MARITIME TRANSPORT
330000 m3 Verolme LNG carrier, 3:25877
Algerian perspective on maritime transport of LNG (Financing; contracts), 3:25871
Arctic islands LNG, 3:25872
Experiences in the commissioning of liquid natural gas carriers, 3:25875
New Invar membrane containment system for construction of LNG carriers, 3:25880
Operational experience with LNG ships, 3:25874
Prototype tank test of semi-membrane LNG carrier, 3:25878
Review of current LNG ship technology and an attempt to rationalize, 3:25869
Risk management in marine transportation of LNG, 3:25844
Spherical LNG tanks on continuous cylindrical skirts: a shipbuilder and licenser's experience, 3:25879
Transfer system of completed spherical tank for LNG carrier, 3:25868
Twelve years operating experience with Methane Princess and Methane Progress, 3:25876
LIQUEFIED NATURAL GAS/MARKET
Future market for LNG in the United States, 3:25848
LIQUEFIED NATURAL GAS/MATERIALS HANDLING
LNG offshore handling, 3:25841
LIQUEFIED NATURAL GAS/MEETINGS
Fifth international conference on liquefied natural gas. Volume I (Role in world energy supply; LNG technology; economics), 3:25845
Fifth international conference on liquefied natural gas. Volume II (Financing and legal aspects of trade; transportation), 3:25857
LIQUEFIED NATURAL GAS/SAFETY
Approach to liquefied natural gas (LNG) safety and environmental control research, 3:25858 (DOE/EV-0002)
Risk management in marine transportation of LNG, 3:25844
LIQUEFIED NATURAL GAS/STORAGE
Insulation system for low temperature service double wall tank, 3:25885
Some legal aspects of a LNG terminal establishment and operation in France, 3:25890
Tests at the FOS terminal on the LNG behavior in the big tanks, 3:25888
Ultra low-temperature LNG compressors, 3:25889
LIQUEFIED NATURAL GAS/TRADE
Prospects of LNG export and its limitations, 3:25847
Situation of LNG in Europe, 3:25849
World LNG trade: present status and long term prospects, 3:25851
World LNG trade and the competitiveness of present and projected prices, 3:25856
LIQUEFIED NATURAL GAS/TRANSPORT
Legal problems of long term LNG contracts, 3:25863
LNG offshore handling, 3:25841
Movements and stress characteristics of LNG piping, 3:25867
LIQUEFIED NATURAL GAS/UNDERGROUND STORAGE
Brittle fracture initiation characteristics of thin mild steel plate for the gas barrier of LNG underground membrane tank, 3:25884
Development and operational experiences of LNG in-ground storage tanks in Japan. Parts I and II, 3:25886
Studies on the storage of LNG in salt cavities, 3:25887
LIQUEFIED PETROLEUM GASES/MARITIME TRANSPORT
Studies on defect occurrence of LPG tank insulation executed in winter, 3:25866
LIQUEFIED PETROLEUM GASES/PRODUCTION
Relaxation of variable torque in the shafting for LPG compressors, 3:25834
LIQUEFIED PETROLEUM GASES/STORAGE
Refrigerated LPG storage and transfer facility for thermal power generation, 3:25883
LIQUEFIERS
See CONDENSERS
LIQUID COLUMN CHROMATOGRAPHY/EQUIPMENT
Laser two-proton excited fluorometric detection for high pressure liquid chromatography, 3:26837 (IS-T-792)
LIQUID METAL COOLED REACTORS/FUEL ELEMENT CLUSTERS
Fuel assembly for a nuclear reactor (Patent), 3:26330
LIQUID METAL FAST BREEDER REACTORS
See LMFBR TYPE REACTORS
LIQUID METAL TEST FACILITIES
See TEST FACILITIES
LIQUID SCINTILLATION DETECTORS/OPTIMIZATION
Optimization of the detector and associated electronics used for high-resolution liquid-scintillation alpha spectroscopy, 3:26829
LIQUID WASTES
See also WASTE WATER
LIQUID WASTES/DECONTAMINATION
Improvement on removal of radio-cobalt from waste water by ferric hydroxide coagulation-flocculation process using diethyldithiocarbamate, 3:25931
LIQUIDS/DIFFUSION
Transport of liquids and gases through coatings, 3:26689
LIQUIDS/INTERFACES
Pressure generation due to a temperature discontinuity at a liquid-liquid plane interface, 3:27087
LIQUIDS/MIXING
Experimental investigation of the displacement of uniform mixing nonnewtonian systems, 3:25758
LITHIUM/ABSORPTION SPECTRA
Lithium local-orbital energy bands using Kohn-Sham and near-Hartree-Fock exchange, 3:26606
LITHIUM/AFFINITY
Binding of Li^+ to Lewis bases in the gas phase. Reversals in methyl substituent effects for different reference acids, 3:26673
LITHIUM/AUGER EFFECT
Lithium local-orbital energy bands using Kohn-Sham and near-Hartree-Fock exchange, 3:26606
LITHIUM/BINDING ENERGY
Binding of Li^+ to Lewis bases in the gas phase. Reversals in methyl substituent effects for different reference acids, 3:26673
LITHIUM/EMISSION SPECTRA
Lithium local-orbital energy bands using Kohn-Sham and near-Hartree-Fock exchange, 3:26606
LITHIUM/ENERGY-LEVEL DENSITY
Lithium local-orbital energy bands using Kohn-Sham and near-Hartree-Fock exchange, 3:26606
LITHIUM/NATURAL OCCURRENCE
New energy-related uses for lithium encourages search for new sources, 3:27020
LITHIUM/X-RAY SPECTRA
Emission and absorption x-ray edges of Li, 3:26607
LITHIUM 6/NUCLEAR REACTION YIELD
Mechanisms for Li and Be production in the $^{14}N + {}^{12}C$ reaction, 3:27336
LITHIUM 6 TARGET/DEUTERON REACTIONS
Absolute cross sections for deuteron-induced reactions on ^6Li at energies below 1 MeV, 3:27337
LITHIUM 7/NUCLEAR REACTION YIELD
Mechanisms for Li and Be production in the $^{14}N + {}^{12}C$ reaction, 3:27336
LITHIUM 7 REACTIONS/COMPOUND-NUCLEUS REACTIONS
High-spin states in ^{64}Zn, 3:27357
High-spin states in ^{70}Ge, 3:27358
LITHIUM COMPOUNDS/FABRICATION
Advanced fuel cell development. Progress report, July-September 1977 (β-$LiAlO_2$ electrolytes), 3:26542 (ANL-77-79)
LITHIUM HYDRIDES/CHEMICAL RADIATION EFFECTS
Effects of γ-ray radiation on the thermal decomposition of lithium aluminum hydride powder, 3:26697

LITHIUM HYDRIDES/PYROLYSIS
Effects of γ-ray radiation on the thermal decomposition of lithium aluminum hydride powder, 3:26697
LITHIUM-SULFUR BATTERIES/RESEARCH PROGRAMS
Federal battery program for transportation uses, 3:26485 (CONF-7606127-1)
LMFBR TYPE REACTORS
See also CLINCH RIVER BREEDER REACTOR
EBR-2 REACTOR
FFTF REACTOR
What will the fast breeder bring us. As an important interlude, nuclear power utilization may be prolonged by fast breeders: but it may also end as a catastrophe, 3:26457
LMFBR TYPE REACTORS/BREEDING BLANKETS
WARD blanket assembly pre-test predictions by SUPERENERGY, 3:26281 (COO-2245-40TR)
LMFBR TYPE REACTORS/COMPARATIVE EVALUATIONS
Laser driven fusion fission hybrids, 3:27681 (UCRL-79653(Rev.1))
LMFBR TYPE REACTORS/CONTAINMENT BUILDINGS
Process for the continuous control of the seal and strength of the containment of a reactor utilizing said process (Patent; LMFBR), 3:26289 (ANL-Trans-1111)
LMFBR TYPE REACTORS/COOLANT CLEANUP SYSTEMS
Installation for purifying the liquid metal used for cooling the core of a fast neutron reactor (Patent), 3:26287 (ANL-Trans-1113)
LMFBR TYPE REACTORS/ENERGY POLICY
SNR-carbide program: its position between present and future, 3:26295
LMFBR TYPE REACTORS/EXCURSIONS
Fracture mechanics of thin wall cylindrical pressure vessels: an interim review, 3:26442 (PNL-2417)
Summary and evaluation of fuel dynamics transient-overpower experiments: status 1974, 3:26431 (ANL-77-44)
LMFBR TYPE REACTORS/FIRES
Extinction of metal fires, 3:26471
LMFBR TYPE REACTORS/FLOWMETERS
Sodium flow calibration using a pulsed neutron activation technique on a 400mm (16 inch) pipe at LMEC, 3:26278 (ANL-CT-78-9)
LMFBR TYPE REACTORS/FUEL ASSEMBLIES
Analysis of the feasibility of implementing an implicit temporal differencing scheme in the SUPERENERGY code, 3:26279 (COO-2245-35TR)
Approximate method for predicting temperature distribution in wire wrapped fuel assemblies of a LMFBR, 3:26280 (COO-2245-37TR)
LMFBR TYPE REACTORS/FUEL CANS
Fracture mechanics of thin wall cylindrical pressure vessels: an interim review, 3:26442 (PNL-2417)
Fuel rod for liquid metal-cooled nuclear reactors (Patent), 3:26329
Status of international fuel cladding development, 3:26326
LMFBR TYPE REACTORS/FUEL CYCLE
Development of advanced fuels in Switzerland, 3:26298
Energy from nuclear reactors. Pt. 4. The fast breeder: better utilization of uranium, 3:26291
SNR-carbide program: its position between present and future, 3:26295
LMFBR TYPE REACTORS/FUEL ELEMENT FAILURE
Advanced fuels safety comparisons, 3:26477
Case for fuel redesign after in pile safety experiments: the "COMMANDO" tests, 3:26315
Experimental study of advanced fuel-pin failure phenomena, 3:26313
GFEK experimental approach to carbide fuel element licensing, 3:26314
U.S. advanced fuels safety program, 3:26312
LMFBR TYPE REACTORS/FUEL ELEMENTS
Safety device in a nuclear reactor fuel rod with a closed fission gas plenum (Patent), 3:26327
LMFBR TYPE REACTORS/FUEL PARTICLES
Properties and irradiation behavior of advanced oxide particle fuel, 3:26305
LMFBR TYPE REACTORS/FUEL PELLETS
Experimental study of advanced fuel-pin failure phenomena, 3:26313
LMFBR TYPE REACTORS/FUEL PINS
Advanced fuels safety comparisons, 3:26477
Advanced LMFBR fuels, 3:26292
Analytical comparison of the irradiation behavior of fast reactor carbide and oxide fuel pins, 3:26319
Assumptions, constraints and methodology of ANL advanced fuels system studies, 3:26322
Case for fuel redesign after in pile safety experiments: the "COMMANDO" tests, 3:26315
Chemical state of irradiated carbide fuel pins, 3:26641
CNEN program on advanced LMFBR fuels, 3:26299
Correlation between properties and irradiation behavior for carbide, carbonitride and nitride fuels, 3:26316
Creep behavior of mixed-carbide advanced nuclear fuel, 3:26635
Design and performance of shroud tubes, 3:26325
Development of advanced fuels in Switzerland, 3:26298
Development of LMFBR core designs using reference and advanced oxide fuel, 3:26321
Experience and future plan of fast reactor oxide fuels irradiation in Japan, 3:26301
French advanced fuels development program, 3:26296
French irradiation test experience for carbide fuels, 3:26309
Fuel properties of advanced fuels (U,Pu)CN important for out-of-pile and in-pile kinetics, 3:26634
German carbide irradiation test experience for fast reactors, 3:26308
GFEK experimental approach to carbide fuel element licensing, 3:26314
Investigation of sodium-bonded carbide fuel assembly design, 3:26324
Irradiation behavior of sphere-pac carbide fuel, 3:26310
Irradiation experiments of uranium carbide, carbonitride, and nitride fuels in JAERI, 3:26311
Irradiation performance analysis of UK fast reactor fuel, 3:26317
Japanese development program for advanced LMFBR fuels, 3:26297
LIFE code system for analysis of oxide fuel pin thermal/structural behavior, 3:26320
Mechanical behavior of a fuel pin for fast reactors: effect of the fuel form and of the approach-to-power on the change of the fuel stack length under irradiation, 3:26302
Mixed-nitride fuel performance in EBR-II, 3:26306
Optimization system design studies of advanced carbide fuel, 3:26323
Progress in modeling carbide and nitride fuel performance in advanced LMFBRs, 3:26318
Safety aspects of carbide irradiations in FTR driver positions, 3:26476
Some observations on oxygen and carbon potentials in U-Pu-O and U-Pu-C systems, 3:26599
Thermophysical properties of liquid uranium carbide, 3:26633
UK irradiation experience relevant to advanced oxide fuel concepts for LMFBR's, 3:26300
UK irradiation experience relevant to advanced carbide fuel concepts for LMFBR's, 3:26307
UK strategy and programmes for advanced LMFBR fuels, 3:26294
US advanced LMFBR fuels development program, 3:26293
US experience in irradiation testing of advanced oxide fuels, 3:26303
US-UK technical exchange breeder reactor fuels: fuel pin chemistry, 3:26282 (HEDL-6297)
LMFBR TYPE REACTORS/LOSS OF FLOW
Final report on TREAT Test R3, a single-pin loss-of-flow experiment, 3:26432 (ANL-77-54)
LMFBR TYPE REACTORS/MELTDOWN
Final report on TREAT Test R3, a single-pin loss-of-flow experiment, 3:26432 (ANL-77-54)
LMFBR TYPE REACTORS/PRIMARY COOLANT CIRCUITS
Bubble dynamics in a superheated liquid, 3:26277 (ANL-77-20)
LMFBR TYPE REACTORS/REACTOR CHARGING MACHINES
Turnstile device for fuel unloading of nuclear reactors (Patent; LMFBR), 3:26288 (ANL-Trans-1112)
LMFBR TYPE REACTORS/REACTOR COOLING SYSTEMS
Evaluations of the piping system inelastic analysis computer program PIRAX2, 3:26276 (AI-DOE-13216)
Sodium-to-gas leak detection. Annual technical progress report, government fiscal year 1977, 3:26275 (AI-DOE-13211)
LMFBR TYPE REACTORS/REACTOR CORE DISRUPTION
Advanced fuels safety comparisons, 3:26477
Analysis of core disruptive accidents in carbide-fueled LMFBRs, 3:26475
Breeder Reactor Aerosol Release and Transport Program. Quarterly progress report, April-June 1977, 3:26439 (ORNL/NUREG/TM-142)
Safety aspects of carbide irradiations in FTR driver positions, 3:26476
LMFBR TYPE REACTORS/REACTOR CORE RESTRAINTS
Device for supporting the core of a fast neutron reactor (Patent), 3:26286 (ANL-Trans-1114)
LMFBR TYPE REACTORS/REACTOR CORES
Investigation of sodium-bonded carbide fuel assembly design, 3:26324
LMFBR TYPE REACTORS/REACTOR SAFETY
Analysis of core disruptive accidents in carbide-fueled LMFBRs, 3:26475
Energy from nuclear reactors. Pt. 5. Fast breeder reactor safety, 3:26468
U.S. advanced fuels safety program, 3:26312

LMFBR TYPE REACTORS/REACTOR VESSELS
Device for thermal shielding of a reactor vessel (Patent; LMFBR), 3:26285 (ANL-Trans-1121)
Process for the continuous control of the seal and strength of the containment of a reactor utilizing said process (Patent; LMFBR), 3:26289 (ANL-Trans-1111)
LMFBR TYPE REACTORS/SEALS
Sodium technology and cover gas seal development programs. Quarterly technical progress report, July-September 1977, 3:26274 (AI-DOE-13208)
LMFBR TYPE REACTORS/VALVES
SPTF Flow Loop 18 inch butterfly valve cavitation test report, SPTF-LPP, 3:26284 (TID-28094)
LMFBR TYPE REACTORS/VOID COEFFICIENT
Calculation of the reactivity due to bubble collapse with the probability table method, 3:26283 (ORNL/CSD/TM-35)
LNG
See LIQUEFIED NATURAL GAS
LNG PLANTS
LNG peak-shaving plant at Maasvlakte, 3:25852
Situation of LNG in Europe, 3:25849
LNG PLANTS/GAS TURBINES
Nitrogen gas turbines for LNG regasification, 3:25840
LNG PLANTS/OFFSHORE OPERATIONS
LNG offshore handling, 3:25841
LNG PLANTS/OFFSHORE SITES
LNG plants on floating structures: intermediate report on an extensive test program, 3:25870
LNG PLANTS/OWNERSHIP
Ownership transfer of LNG plants, 3:25835
LNG PLANTS/PERFORMANCE
Brunei liquefied natural gas plant, 3:25836
First years of operation of the Skikda LNG plant with a discussion of mercury chemical corrosion of aluminum cryogenic exchangers, 3:25837
Operational flexibility of LNG plants using the propane precooled multicomponent refrigerant MCR process, 3:25838
LNG PLANTS/RELIABILITY
Safety and reliability of floating LNG production facilities, 3:25843
LNG PLANTS/SAFETY
Safety and reliability of floating LNG production facilities, 3:25843
LOAD MANAGEMENT/BIBLIOGRAPHIES
Electric power load management (citations from the NTIS data base). Report for 1964-July 1977, 3:26197 (NTIS/PS-77/0690)
LOAD MANAGEMENT/COST BENEFIT ANALYSIS
Impact of load management strategies upon electric utility costs and fuel consumption. Final report, 3:26198 (PB-271083)
LOADING MACHINES (REACTOR)
See REACTOR CHARGING MACHINES
LOADING (REACTOR)
See REACTOR FUELING
LOFT REACTOR/REACTOR SIMULATORS
Hybrid computer simulation of the LOFT plant, 3:26228 (LTR-10-2B)
LONGWALL MINING
See also COAL MINING
LONGWALL MINING/BIBLIOGRAPHIES
Mechanized longwall mining, a review emphasizing foreign technology. Information circular 1977, 3:25695 (PB-272699)
LONGWALL MINING/FIRE HAZARDS
Longwall ignition suppression. Final report, 3:25694 (PB-270696)
LONGWALL MINING/FIRE PREVENTION
Longwall ignition suppression. Final report, 3:25694 (PB-270696)
LONGWALL MINING/REVIEWS
Mechanized longwall mining, a review emphasizing foreign technology. Information circular 1977, 3:25695 (PB-272699)
LOSS OF COOLANT/BLOWDOWN
Method for the analysis of blowdown induced forces in a reactor vessel, 3:26433 (CENPD-252-NP)
LOSS OF COOLANT/MATHEMATICAL MODELS
TECAR, a new program for LOCA analysis (BWR; PWR), 3:26448
LOSS OF FLOW
Final report on TREAT Test R3, a single-pin loss-of-flow experiment (LMFBR), 3:26432 (ANL-77-54)
LOSS OF FLUID TEST REACTOR
See LOFT REACTOR
LOW BTU GAS/COMBUSTION PROPERTIES
Boiler burner design criteria for retrofit with low-Btu gases, 3:26778 (CONF-770885-1)
Development of combustion data to utilize low-Btu gases as industrial process fuels. Project 8985 monthly status report, November 1-November 30, 1977, 3:25712 (FE-2489-18)
LOW BTU GAS/PRODUCTION
Low-Btu gas as an industrial energy source, 3:25625 (CONF-7710116-1)
LOW BTU GAS/USES
Low-Btu gas as an industrial energy source, 3:25625 (CONF-7710116-1)
LOW-BETA PLASMA/DIFFUSION
Quasi-linear diffusion and particle transport in inhomogeneous plasmas, 3:27510
LOW-BETA PLASMA/TURBULENCE
Quasi-linear diffusion and particle transport in inhomogeneous plasmas, 3:27510
LP-GAS
See LIQUEFIED PETROLEUM GASES
LUBRICANTS
See also GREASES
LUBRICATING OILS
LUBRICANTS/OXIDATION
Deuterated fluids: deuterated synthetic hydrocarbon fluid and grease. Final report, 3:26690 (AD-A-042618)
LUBRICATING OILS
See also WASTE OILS
LUBRICATING OILS/PRODUCTION
Increasing the efficiency of production of high. VI. Residual lube oils from Mangyshlak crude, 3:25788
LURGI PROCESS/DEMONSTRATION PLANTS
Fossil energy demonstration plants, 3:25642 (TID-28182)
LUTETIUM 175 TARGET/NEUTRON REACTIONS
Cross sections for (n,2n) and (n,3n) reactions above 14 MeV, 3:27353
LUTETIUM COMPOUNDS/KNIGHT SHIFT
Systematics in the Knight shift of rare-earth monopnictides, 3:26600
LYASES/BIOCHEMICAL REACTION KINETICS
Photorepair of uv damage to DNA: purification and properties of DNA photolyase (the DNA-photoreactivating enzyme). Progress and final reports, August 1, 1976-July 31, 1977, 3:26948 (ORO-3630-26)
LYASES/PURIFICATION
Photorepair of uv damage to DNA: purification and properties of DNA photolyase (the DNA-photoreactivating enzyme). Progress and final reports, August 1, 1976-July 31, 1977, 3:26948 (ORO-3630-26)
LYSINE/BIOCHEMICAL REACTION KINETICS
Photorepair of uv damage to DNA: purification and properties of DNA photolyase (the DNA-photoreactivating enzyme). Progress and final reports, August 1, 1976-July 31, 1977, 3:26948 (ORO-3630-26)

M

MACHINE PARTS/ENERGY LOSSES
Strategy for energy conservation through tribology, 3:26706 (TID-28175)
MACHINE PARTS/FRICTION
Strategy for energy conservation through tribology, 3:26706 (TID-28175)
MAGNESIUM 24 TARGET/HELIUM 3 REACTIONS
Reappraisal of the $^{24}Mg(^{3}He,t)^{24}Al$ data to low-lying 1^{+} states, 3:27339
MAGNESIUM 24 TARGET/OXYGEN 16 REACTIONS
Systematics of O + Mg fusion (18 to 50 MeV (c.m.): excitation function), 3:27340 (ANL-77-60)
MAGNESIUM 24 TARGET/SULFUR 32 REACTIONS
Energy dependence of $^{32}S + ^{24}Mg$ fusion cross sections (100 to 200 MeV), 3:27341 (ANL-77-60)
MAGNESIUM 25/MAGNETIC MOMENTS
Elastic electron scattering from the multipole moment distributions of ^{25}Mg, 3:27343
MAGNESIUM 25 TARGET/ELECTRON REACTIONS
Elastic electron scattering from the multipole moment distributions of ^{25}Mg, 3:27343
MAGNESIUM OXIDES/ELECTRONIC STRUCTURE
High-temperature and ionization-induced effects in lithium-doped MgO single crystals, 3:26596
MAGNESIUM OXIDES/EMISSIVITY
Infrared emissivities of micron-sized particles of C, MgO, Al_2O_3, and ZrO_2. Final report, 3:26636 (AD-A-042144)
MAGNET COILS/DESIGN
Magnetics design for ripple-assisted beam injection into the ISX-B and TFTR Tokamaks, 3:27592 (CONF-771029-203)
MAGNET COILS/ENERGY LOSSES
Power loss problems in EXTRAP coil systems, 3:27639 (TRITA-PFU-77-02)
MAGNET COILS/POWER SUPPLIES
GAC-ANL TNS scoping studies. Status report for FY-77, October 1, 1976-September 30, 1977. Volume XI. TNS doublet

tokamak ohmic-heating power supply study. LA-7053-MS, 3:27648 (GA-A-14614(Vol.11))
MAGNET COILS/SUPPORTS
Stress analysis of supporting tube of helical winding in stellarator device, 3:27632 (IPPJ-T-25)
MAGNET COILS/SWITCHES
Dynamic behavior of a resistive transfer circuit with a superconducting switch, 3:27647 (EUR-5602)
MAGNETIC COILS
See MAGNET COILS
MAGNETIC ENERGY STORAGE
See also SUPERCONDUCTING MAGNETS
MAGNETIC ENERGY STORAGE/SUPERCONDUCTING COILS
Application of a two superconducting ellipsoidal coil system without external magnetic field as an inductive energy storage (Part 1), 3:27651 (LA-tr-78-12)
MAGNETIC ENERGY STORAGE/SWITCHES
Results of research into superconducting switches with high specific switching capacity, 3:27650 (LA-tr-78-13)
MAGNETIC FIELD CONFIGURATIONS
Classical diffusion in the presence of an X point, 3:27638 (PPPL-EPRI-7)
MAGNETIC FIELDS
See also INTERPLANETARY MAGNETIC FIELDS
MAGNETIC FIELDS/BIOLOGICAL EFFECTS
Biomagnetism: a review (Effects of magnetic fields on man), 3:27002 (SLAC-PUB-1984)
MAGNETIC FIELDS/ELECTROMOTIVE FORCE
Spinning magnets and Jehle's model of the electron, 3:27258
MAGNETIC MIRROR CONFIGURATIONS/NEGATIVE MASS INSTABILITY
Influence of axial energy spread on the negative-mass instability in a relativistic nonneutral E layer, 3:27547
MAGNETIC MIRROR CONFIGURATIONS/ORBITS
Theoretical investigations relevant to magnetic fusion energy research. Progress report, January 1, 1977-January 1, 1978, 3:27537 (CONF-771136-25)
MAGNETIC MIRROR CONFIGURATIONS/PLASMA MICROINSTABILITIES
Theoretical investigations relevant to magnetic fusion energy research. Progress report, January 1, 1977-January 1, 1978, 3:27537 (CONF-771136-25)
MAGNETIC MIRROR TYPE REACTORS/BEAM INJECTION HEATING
Neutral-injection-induced transport in mirror-confined plasmas, 3:27464
MAGNETIC MIRROR TYPE REACTORS/CYCLOTRON INSTABILITY
Nonlinear dynamics of drift-cyclotron instability, 3:27548
MAGNETIC MIRROR TYPE REACTORS/DESIGN
Mirror reactor studies, 3:27602
MAGNETIC MIRROR TYPE REACTORS/DIRECT ENERGY CONVERTERS
Experimental and computational results on direct energy conversion for mirror fusion reactors, 3:27666
MAGNETIC MIRROR TYPE REACTORS/DRIFT INSTABILITY
Nonlinear dynamics of drift-cyclotron instability, 3:27548
MAGNETIC MIRROR TYPE REACTORS/PLASMA CONFINEMENT
Transient confinement of a high-density plasma in a multiple-mirror magnetic-field configuration, 3:27463
MAGNETIC MIRROR TYPE REACTORS/PLASMA MACROINSTABILITIES
Ballooning instabilities in toroidally linked mirror systems, 3:27558
MAGNETIC MIRROR TYPE REACTORS/TRANSPORT THEORY
Neutral-injection-induced transport in mirror-confined plasmas, 3:27464
MAGNETIC MIRRORS
See also 2X DEVICES
MAGNETIC MIRRORS/LASER-RADIATION HEATING
High-temperature high-quality deuterium plasma production by laser beam(s) by means of on-line computer control technique, 3:27427 (EUR-5602)
MAGNETIC MONOPOLES/BOUND STATE
Electric and magnetic dipole moments of the bound system of a Dirac particle and a fixed magnetic monopole, 3:27270
MAGNETIC MONOPOLES/ELECTRIC DIPOLE MOMENTS
Electric and magnetic dipole moments of the bound system of a Dirac particle and a fixed magnetic monopole, 3:27270
MAGNETIC MONOPOLES/ENERGY SPECTRA
Spectra of fermions in monopole fields: Exactly soluble models, 3:27269
MAGNETIC MONOPOLES/MAGNETIC DIPOLE MOMENTS
Electric and magnetic dipole moments of the bound system of a Dirac particle and a fixed magnetic monopole, 3:27270
MAGNETIC MONOPOLES/PARTICLE INTERACTIONS
Geometry and interactions of instantons (SU(4) and SU(2) groups, gauge fields), 3:27182
MAGNETIC RESONANCE/RESEARCH PROGRAMS
Optical and zero field magnetic resonance spectroscopy of inorganic molecular solids. Final report, 1 June 1975-31 May 1977 (Dept. of Chemistry, Colorado State Univ., Fort Collins), 3:26645 (AD-A-043340)
MAGNETIC SURFACES
See MAGNETIC FIELD CONFIGURATIONS
MAGNETIC SURVEYS/WAVE PROPAGATION
Iterative reconstruction of underground refractive index distributions from cross-borehole transmission data, 3:27006 (UCRL-52348)
MAGNETIC-PUMPING HEATING
To the theory of heating of collisional plasma by means of magnetic pumping by axial-asymmetric variable fields, 3:27465
MAGNETOACOUSTIC WAVES/DISPERSION RELATIONS
Note on the characters of the dispersion equation of fast magnetosonic wave near the second ion-cyclotron harmonic, 3:27561 (EUR-CEA-FC-895)
MAGNETOHYDRODYNAMIC CHANNELS
See MHD CHANNELS
MAGNETOHYDRODYNAMIC GENERATORS
See MHD GENERATORS
MAGNETOHYDRODYNAMICS/BOUNDARY LAYERS
Boundary-layer blockage with mass transfer, 3:27094
MAGNETOHYDRODYNAMICS/STEADY FLOW
Mode crossing in a Lagrangian system, 3:27090
MAGNETOSPHERE/RESEARCH PROGRAMS
Aerospace Corporation space sciences program: report to COSPAR CY 1976. Interim report, 3:27026 (AD-A-043372)
Study of the magnetic field annihilation process in the magnetosphere and some applications (electric currents in the Trans-Alaska pipeline induced by auroral activity) (Geophysical Institute, Univ. of Alaska, Fairbanks), 3:27045 (RLO/2229/T5-7)
MAGNETS
See also SUPERCONDUCTING MAGNETS
MAGNETS/SPIN
Spinning magnets and Jehle's model of the electron, 3:27258
MAMMALS/ARCHAEOLOGY
Sea mammals: resources and population, 3:26938 (TID-26712)
MAMMALS/BODY TEMPERATURE
Sea otter metabolism and heat economy, 3:26970 (TID-26712)
MAMMALS/COMMUNITIES
Biotic components, 3:25946 (PNL-2253)
MAMMALS/DATA COMPILATION
Sea mammals: resources and population, 3:26938 (TID-26712)
MAMMALS/ECOLOGY
Ecological interactions involving the sea otter, 3:26928 (TID-26712)
MAMMALS/FEEDING
Population estimates and feeding behavior of sea otters, 3:26942 (TID-26712)
MAMMALS/FOOD
Sea otter metabolism and heat economy, 3:26970 (TID-26712)
MAMMALS/METABOLISM
Sea otter metabolism and heat economy, 3:26970 (TID-26712)
MAMMALS/POPULATION DENSITY
Ecological interactions involving the sea otter, 3:26928 (TID-26712)
Population estimates and feeding behavior of sea otters, 3:26942 (TID-26712)
MAN
See also PATIENTS
PERSONNEL
MAN/AGE GROUPS
Population dose commitments due to radioactive releases from nuclear power plant sites in 1975, 3:26992 (PNL-2439)
MAN/INTERNAL IRRADIATION
Standardized radioactive decay data sets for use in radiation dosimetry, 3:26991 (IAEA-SM-222/51)
MAN/PHYSIOLOGY
Biomagnetism: a review (Effects of magnetic fields on man), 3:27002 (SLAC-PUB-1984)
MAN/RADIATION DOSE DISTRIBUTIONS
Standardized radioactive decay data sets for use in radiation dosimetry, 3:26991 (IAEA-SM-222/51)
MAN/RADIONUCLIDE KINETICS
Population dose commitments due to radioactive releases from nuclear power plant sites in 1975, 3:26992 (PNL-2439)
MANGANESE/EMISSION SPECTROSCOPY
Determination of trace elements in soft, hard, and saline waters by the inductively coupled plasma, multi-element atomic emission spectroscopic (ICP-MAES) technique, 3:26664
MANGANESE/ION EXCHANGE
Cation exchange of 53 elements in nitric acid, 3:26665 (LA-7083)

MANGANESE/PHOTOEMISSION
X-ray photoemission spectra of the valence bands of the 3d transition metals, Sc to Fe, 3:26608
MANGANESE 57/ENERGY LEVELS
New isotopes of interest to explosive nucleosynthesis (Half-lives, branching ratios, J, π), 3:27355 (ANL-77-60)
MANGANESE 60/BETA-MINUS DECAY
New isotopes of interest to explosive nucleosynthesis (Half-lives, branching ratios, J, π), 3:27355 (ANL-77-60)
MANGANESE 60/GROUND STATES
New isotopes of interest to explosive nucleosynthesis (Half-lives, branching ratios, J, π), 3:27355 (ANL-77-60)
MANGANESE ALLOYS/SPIN WAVES
Magnetic excitations in the weak itinerant ferromagnet MnSi, 3:26610
MANURES/ANAEROBIC DIGESTION
Anaerobic fermentation of animal and crop residues: summary. Quarterly progress report (second), April 1, 1977-June 10, 1977, 3:26017 (COO/2991-19)
Biological conversion of biomass to methane, 3:26018 (COO/2991-19)
Biomass production from animal wastes by photosynthetic bacteria, 3:26028
Design and analysis of a cow manure heat exchanger for the 100,000 gallon methane-producing digester in Monroe, Washington, 3:26014 (COO/2991-19)
Energy relationships for a 320-acre Iowa farm: an attempt to increase production of grain and meat while rendering the farm energy self-sufficient by generating methane through anaerobic fermentation of residues, 3:26020 (ERDA/USDA-19464/76/FR-3)
Monfort waste conversion demonstration. Progress report, April 1, 1977-June 4, 1977, 3:26016 (COO/2991-19)
MANURES/PHYSICAL PROPERTIES
Anaerobic fermentation of animal and crop residues: summary. Quarterly progress report (second), April 1, 1977-June 10, 1977, 3:26017 (COO/2991-19)
MANY-BODY PROBLEM
See also FOUR-BODY PROBLEM
THREE-BODY PROBLEM
MANY-BODY PROBLEM/MATRIX ELEMENTS
Matrix elements in the method of angular potential functions, 3:27387
MANY-BODY PROBLEM/PARTITION FUNCTIONS
Statistical mechanics of a (1 + 1) -dimensional quantum field theory at finite density and temperature, 3:27276
MARINE ECOSYSTEMS
See AQUATIC ECOSYSTEMS
MARINE VEHICLE ACCIDENTS
See ACCIDENTS
MASS SPECTROMETERS/DATA ACQUISITION SYSTEMS
Application of a GC/MS data system at Rocky Flats (Analysis of organic compounds), 3:26839 (RFP-2558)
MASS SPECTROMETERS/PERFORMANCE TESTING
Initial results with the Berkeley on-line mass separator-RAMA (Recoil Atom Mass Analyzer (RAMA)), 3:26803 (LBL-7156)
MASSACHUSETTS INSTITUTE TECHN. ALCATOR
See ALCATOR DEVICE
MASSIVE VECTOR MESON MODEL
See GLUON MODEL
MASSLESS PARTICLES/PROPAGATOR
Scalar propagators in a pseudoparticle field, 3:27259
MATHEMATICAL MANIFOLDS/QUANTUM OPERATORS
Geometric quantization: an extended procedure, 3:27411
Geometric quantization of symplectic manifolds, 3:27423
MATHEMATICAL OPERATORS
See also QUANTUM OPERATORS
MATHEMATICAL OPERATORS/EIGENFUNCTIONS
Some recent results in bifurcation theory, 3:27421
MATHEMATICS
See also FUNCTIONAL ANALYSIS
Permutations of the positive integers with restrictions on the sequence of differences, 3:27715
MATHEMATICS/MEETINGS
Mathematical physics and physical mathematics (Warsaw, Poland, March 25-30, 1974), 3:27419
MEASURING INSTRUMENTS
See also DISPLACEMENT GAGES
FLOWMETERS
LEVEL INDICATORS
RADIOMETERS
SPECTROPHOTOMETERS
THERMOCOUPLES
MEASURING INSTRUMENTS/DESIGN
General considerations of the design of instruments for use in coal mines, 3:25703
MEASURING INSTRUMENTS/MEETINGS
Operation of instruments in adverse environments, 1976, 3:26816
MECHANICAL STRUCTURES
See also BELLOWS
MECHANICAL STRUCTURES/MECHANICAL VIBRATIONS
Approximate method for calculating free vibrations of a large-wind-turbine tower structure, 3:26126 (ERDA/NASA/1028-77/12)
MECHANICAL STRUCTURES/SEISMIC EFFECTS
Stress of structures caused by earthquakes according to calculation and measurement, 3:26469
MECHANICAL STRUCTURES/STRESS ANALYSIS
Approximate method for calculating free vibrations of a large-wind-turbine tower structure, 3:26126 (ERDA/NASA/1028-77/12)
MECHANICAL STRUCTURES/SYSTEM FAILURE ANALYSIS
Structural reliability methodology: application at the system level, 3:26435 (GEFR-SP-049)
MEDITERRANEAN SEA/HEAT FLOW
Comparison and interpretation of borehole and marine heatflow data from the Mediterranean and Aegean Seas (abstract), 3:26109
MELANOMAS/CYTOLOGICAL TECHNIQUES
Impulse cytophotometric investigations on melanoblastoma, 3:26965 (LA-tr-78-2)
MELANOMAS/HISTOLOGY
Impulse cytophotometric investigations on melanoblastoma, 3:26965 (LA-tr-78-2)
MELTDOWN
Final report on TREAT Test R3, a single-pin loss-of-flow experiment (LMFBR), 3:26432 (ANL-77-54)
MERCURY/ECOLOGICAL CONCENTRATION
Environmental effect of mercury, with particular attention to the Monte Amiata Zone, 3:26885 (ORNL-tr-4479)
MERCURY/ENVIRONMENTAL EFFECTS
Environmental effect of mercury, with particular attention to the Monte Amiata Zone, 3:26885 (ORNL-tr-4479)
MERCURY/ION EXCHANGE
Cation exchange of 53 elements in nitric acid, 3:26665 (LA-7083)
MERCURY/QUANTITATIVE CHEMICAL ANALYSIS
Fate of trace and minor constituents of coal during gasification. Final task report, 3:25641 (PB-270913)
MERCURY 186/ENERGY LEVELS
Shape coexistence in ^{186}Hg and the decay of ^{186}Tl, 3:27370
MERCURY 186/NUCLEAR RADII
Shape coexistence in ^{186}Hg and the decay of ^{186}Tl, 3:27370
MERCURY ALLOYS/ELECTRIC CONDUCTIVITY
Thermal conductivity of indium: mercury amalgams, 3:26614
MERCURY ALLOYS/THERMAL CONDUCTIVITY
Thermal conductivity of indium: mercury amalgams, 3:26614
MESON NONETS/OKUBO MASS FORMULA
Consequences of quark-line (Okubo-Zweig-Iizuka) rule, 3:27218
MESON RESONANCES
See also D RESONANCES
D-1865 RESONANCES
ETA-700 RESONANCES
ETA-958 RESONANCES
F-1260 RESONANCES
F-1514 RESONANCES
F-1540 RESONANCES
*K*RESONANCES*
OMEGA-784 RESONANCES
PHI-1019 RESONANCES
RHO-765 RESONANCES
VECTOR MESONS
MESON RESONANCES/GLUON MODEL
Mesons from gluons, 3:27219
MESON RESONANCES/MASS
New states below 2.2 GeV observed in $e^+ e^-$ annihilations (1.35 to 2.2 GeV), 3:27136 (BNL-23612)
MESON RESONANCES/OKUBO MASS FORMULA
Consequences of quark-line (Okubo-Zweig-Iizuka) rule, 3:27218
MESON RESONANCES/PARTICLE PRODUCTION
Generation of a Pomeron and an f Regge pole in the dual-unitarization program, 3:27209
MESON RESONANCES/PARTICLE WIDTHS
New states below 2.2 GeV observed in $e^+ e^-$ annihilations (1.35 to 2.2 GeV), 3:27136 (BNL-23612)
MESONS
See also MESON RESONANCES
POMERANCHUK PARTICLES
PSEUDOSCALAR MESONS
MESONS/DECAY
etaeta' and ωphi mixing in the nonrelativistic quark model, 3:27179
Hadrons (usual and newly discovered) in gauge theories a dream, 3:27213
Phenomenological model for charmed meson decay, 3:27221
MESONS/ENERGY LEVELS
Baryon excitations in the bag model, 3:27216 (SLAC-PUB-1774)

MESONS/LEPTONIC DECAY
Tests of spontaneous left-right-symmetry breaking, 3:27252
MESONS/MASS SPECTRA
Hadrons (usual and newly discovered) in gauge theories a dream, 3:27213
METABOLIC DISEASES/DIAGNOSTIC TECHNIQUES
Biomedical research and application utilizing cyclotron produced radionuclides. Progress report, January 1 1977-December 31, 1977, 3:26971 (COO/4268-1)
METAL INDUSTRY/ENERGY CONSERVATION
Energy efficiency improvement target for SIC 34. Fabricated metal products. Volume 1. Draft target support document, 3:26557 (PB-269812)
Energy efficiency improvement target for SIC 34. Fabricated metal products. Volume 2. Revised target support document, 3:26558 (PB-269813)
Energy efficiency improvement targets for primary metal industries. SIC 33. Volume I. Draft target support document, 3:26559 (PB-269823)
Energy efficiency improvement targets for primary metal industries. SIC 33. Volume II. Draft target support document. Appendices, 3:26560 (PB-269824)
Energy efficiency improvement targets for primary metal industries. SIC 33. Volume III. Final target report, 3:26561 (PB-269825)
METAL-METAL BATTERIES/RESEARCH PROGRAMS
Federal battery program for transportation uses, 3:26485 (CONF-7606127-1)
METALS
See also ACTINIDES
ALKALI METALS
ALKALINE EARTH METALS
RARE EARTHS
METALS/CREEP
Non-linear least-square fitting approach for determining activation energies for high temperature creep (abstract), 3:26110
METALS/ION CHANNELING
Theory of radiative electron capture by channeled ions, 3:27404
METAMORPHIC ROCKS
See also SANDSTONES
METAMORPHIC ROCKS/ACTIVATION ANALYSIS
Uranium abundance in some Precambrian and Phanerozoic rocks from New Mexico, 3:25912
METEOROLOGY
Energy and the climate, 3:26868 (ORAU/IEA(M)-75-3)
METHANATION/CATALYSTS
Operating experience with the IGT cold-gas recycle methanation process in the HYGAS pilot plant, 3:25623 (CONF-771092-9)
METHANE/BIOSYNTHESIS
A.S.E.F. solid waste to methane gas, Pompano Beach, Florida. Project progress report No. 22, 3:26015 (COO/2991-19)
Anaerobic fermentation of agricultural residues: potential for improvement and implementation. Fourth quarter progress report, March 2, 1977-June 15, 1977, 3:26010 (COO/2991-19)
Best mixing concepts for refuse/sludge for ERDA's biogasification project, 3:26013 (COO/2991-19)
Biochemistry of methanogeness, 3:26026 (SRO-0888-2)
Biological conversion of biomass to methane, 3:26018 (COO/2991-19)
Current status of an ERDA project "permselective membrance control of algal and wood digesters for increased production and chemicals recovery", 3:26009 (COO/2991-19)
Design and analysis of a cow manure heat exchanger for the 100,000 gallon methane-producing digester in Monroe, Washington, 3:26014 (COO/2991-19)
Effect of molecular structure on methane fermentability, 3:26006 (COO/2991-19)
Energy relationships for a 320-acre Iowa farm: an attempt to increase production of grain and meat while rendering the farm energy self-sufficient by generating methane through anaerobic fermentation of residues, 3:26020 (ERDA/USDA-19464/76/FR-3)
Enhancement of methane production with activated carbon, 3:26012 (COO/2991-19)
Heat treatment of organics for increasing anaerobic biodegradability. Quarterly progress report, March 1, 1977-May 31, 1977, 3:26007 (COO/2991-19)
Monfort waste conversion demonstration. Progress report, April 1, 1977-June 4, 1977, 3:26016 (COO/2991-19)
Promoting faster anaerobic digestion: summary of progress and plans, 3:26008 (COO/2991-19)
Technology for the conversion of solar energy to fuel gas. Annual report, 3:25964 (PB-271142)
METHANE/BUILDUP
Methane accumulations in coal mine roof cavities, 3:25691 (BM-RI-8267)
METHANE/CHLORINATION
Design of a homogeneous reactor for the manufacture of chloromethanes, 3:25782
METHANE/DESORPTION
Methane emissions from gassy coals in storage silos, 3:25706 (BM-RI-8269)
METHANE/DIFFUSION
Methane absorption in oil shale and its potential mine hazard. Report of investigations 1977, 3:25893 (PB-271219)
METHANE/FLOW RATE
Effects of hydraulic stimulation on coalbeds and associated strata, 3:25689 (BM-RI-8260)
METHANE/RAMAN SPECTRA
Coherent anti-stokes Raman spectroscopy. Final report, 3:26669 (AD-A-042273)
METHANE/RESOURCE CONSERVATION
Coal and methane gas in the southeastern part of the Piceance Creek basin, Colorado, 3:25688
METHANOL/PRODUCTION
Partial oxidation of fuel oil route to methanol production, 3:25966
METHANOL/STEAM REFORMER PROCESSES
Advanced technology fuel cell program. Interim report, 3:26543 (EPRI-EM-576)
METHANOL/SYNTHESIS
Mechanism of methanol synthesis from carbon dioxide and hydrogen. III. Determination of rates of individual stages using ^{14}CO, 3:25967
Selection of the optimum height-diameter ratio to be used in low-pressure methanol synthesis, 3:25965
METHANOL/USES
Experiments with novel fuels for diesel engines, 3:26591 (BERC/TPR-77/8)
2-METHYLPROPENE/POLYMERIZATION
Polymerization (oligomerization) of isobutyl from eneommercial c_4 hydrocarbon fraction in the presence of soluble organoaluminum catalysts, 3:25776
MFTF DEVICES/NEUTRAL ATOM BEAM INJECTION
Analytical estimates for higher energy neutral beams in MFTF, 3:27660 (UCID-17692)
MHD CHANNELS/ELECTRIC CURRENTS
Two-dimensional electrical effects in a frame-type MHD channel, 3:26537
MHD GENERATORS
See also COAL-FIRED MHD GENERATORS
Translations on USSR science and technology. Physical Sciences and Technology No. 18, 3:26533 (JPRS-69811)
MHD GENERATORS/COMBUSTION CHAMBERS
Special characteristics of the aerodynamic organization of the working process in a conical-type combustion chamber for a magnetohydrodynamic unit, 3:26535
MHD GENERATORS/POWER PLANTS
Complex study on a base-load MHD power station of open cycle, 3:26534
MHD GENERATORS/SUPERCONDUCTING MAGNETS
SPMS-1 superconducting magnet system for an MHD generator, 3:26539 (JPRS-69811)
MICROANALYSIS
Recent advances in analytical electron microscopy, 3:26662 (CONF-770504-)
MICROBIAL FLORA
See MICROORGANISMS
MICROFLORA
See MICROORGANISMS
MICROORGANISMS
See also BACTERIA
PROTOZOA
VIRUSES
YEASTS
MICROORGANISMS/BIODEGRADATION
Influence of microbial activities on availability and biotransport of plutonium, 3:26916 (NVO-171)
MICROORGANISMS/BIOLOGICAL RADIATION EFFECTS
Thermoradiation treats sewage sludge, 3:26576
MICROORGANISMS/ELECTRON MICROSCOPY
Proceedings of the 14th annual electron microscopy colloquium, 3:26952 (CONF-770504-)
MICROORGANISMS/GROWTH
Bio-oxidation of aqueous cyanogens typical of Synthane gasifier by-product water. Progress report, September 1, 1977-November 30, 1977, 3:26947 (COO/4502-1)
MICROPROCESSORS/PROGRAMMING
ACT: an 8080 MACRO processor, 3:27710 (UCID-17722)
MICROSCOPY
See also ELECTRON MICROSCOPY
MICROSCOPY/COMPARATIVE EVALUATIONS
Applications of interference microscopy for measurements on the cell nucleus in comparison with impulse cytophotometry, 3:26966 (LA-tr-78-4)
MICROSPHERES/LASER IMPLOSIONS
Investigation of compression of hollow microspheres irradiated by a laser, 3:27689

MICROWAVE RADIATION/BIBLIOGRAPHIES
Biological effects of nonionizing electromagnetic radiation. Volume II, Number 1. A digest of current literature. Quarterly report June-September 1977, 3:27000 (AD-A-043458)
MICROWAVE RADIATION/BIOLOGICAL RADIATION EFFECTS
Operant behavior and colonic temperature of squirrel monkeys (saimiri sciureus) during microwave irradiation. Interim report, 3:27001 (AD-A-043706)
MILITARY FACILITIES/DUAL-PURPOSE POWER PLANTS
Analysis of nuclear and coal fueled total energy system options for Fort Knox, Kentucky. Final technical report, June 1976-June 1977, 3:26338 (AD-A-043701)
MILITARY FACILITIES/ENERGY CONSUMPTION
Fort Knox regional energy survey. Final report, 3:26511 (AD-A-042456)
MILITARY FACILITIES/ENERGY MANAGEMENT
Energy control system study for Fort Belvoir, Virginia. Final report, 3:26553 (AD-A-042641)
MILITARY FACILITIES/SOLAR HEATING SYSTEMS
Market evaluation study: solar heating and domestic hot water heating in DOD buildings. Final report, 3:26042 (AD-A-042178)
MILITARY FACILITIES/SOLAR WATER HEATING
Market evaluation study: solar heating and domestic hot water heating in DOD buildings. Final report, 3:26042 (AD-A-042178)
MILITARY FACILITIES/TOTAL ENERGY SYSTEMS
Conceptual design Solar Total Energy Large Scale Experiment number 1. Final report (For US Army installation at Fort Hood,Texas), 3:26039 (TID-28013)
MILK/PRODUCTION
Energy use in the dairy industry (report No. 25), 3:26529 (NP-23050)
MILK/RADIOACTIVITY
Solubility of plutonium and americium-241 from rumen contents of cattle grazing on plutonium-contaminated desert vegetation in in vitro bovine gastrointestinal fluids, November 1974-May 1975 (Uptake of transuranics by dairy cows from contaminated forage with emphasis on excretion in milk), 3:26914 (NVO-171)
MILROW EVENT/ENVIRONMENTAL EFFECTS
Aquatic ecology, 3:26924 (TID-26712)
Ecology of marine algae (Prasiola, Rhodochorton, Porphyra, Ulothrix, Alaria, Fucus), 3:26925 (TID-26712)
MINERAL OIL
See LUBRICANTS
MINERAL SPRINGS/CHEMICAL ANALYSIS
Tables of chemical analysis of mineral waters (1961-1966) from the Hot Spring Research Institute of Kanagawa Prefecture, 3:26104
MINERALS
See also CHALCOPYRITE
CLAYS
PYRRHOTITE
URANIUM MINERALS
ZEOLITES
MINERALS/CATALYTIC EFFECTS
Effects of mineral matter on the hydroliquefaction of coal, 3:25663 (SAND-77-1558C)
MINERALS/CHEMICAL REACTION KINETICS
Internally consistent thermodynamic data (abstract), 3:26118
MINERALS/DEPOSITION
Structural knots: important elements of structural boundaries of ancient platforms, 3:27007
MINERALS/MANUALS
Minerals yearbook 1974. Volume III. Area reports: international, 3:27013 (PB-269706)
MINERALS/ROCK-FLUID INTERACTIONS
Ore transport and deposition in the Red Sea geothermal system: a geochemical model, 3:26120
MINERALS/THERMODYNAMIC PROPERTIES
Internally consistent thermodynamic data (abstract), 3:26118
MINERS/COMMUNICATIONS
Underground mine communications. IV. Section-to-place communications. Information circular, 3:25693 (PB-270189)
MINES
See also COAL MINES
MINES/COMMUNICATIONS
Underground mine communications. IV. Section-to-place communications. Information circular, 3:25693 (PB-270189)
MINING EQUIPMENT/DESIGN
Linear cutting rotary head continuous mining machine (Patent), 3:25701
Method of operating a constant depth linear cutting head on a retrofitted continuous mining machine (Patent), 3:25700
MIRRORS (MAGNETIC)
See MAGNETIC MIRRORS
MISSISSIPPI RIVER BASIN/HYDROELECTRIC POWER
Upper Mississippi River Basin above Minnesota River, Minnesota. Appraisal report, water resources appraisal for hydroelectric licensing, 3:25977 (NP-22953)
MISSISSIPPI RIVER BASIN/WATER RESOURCES
Upper Mississippi River Basin above Minnesota River, Minnesota. Appraisal report, water resources appraisal for hydroelectric licensing, 3:25977 (NP-22953)
MIT BATES LINAC/ACCELERATOR FACILITIES
Target cooling (Bates Linac), 3:27314 (ORO-4043-37)
MITOCHONDRIA/BIOCHEMICAL REACTION KINETICS
Yeast mitochondrial DNA specifies tRNA for 19 amino acids. Deletion mapping of the tRNA genes, 3:26950
MODELS (ATOMIC)
See ATOMIC MODELS
MODELS (OPTICAL)
See OPTICAL MODELS
MODELS (PARTICLE)
See PARTICLE MODELS
MODELS (PLASMA)
See PLASMA SIMULATION
MODELS (STATISTICAL)
See STATISTICAL MODELS
MODERATING DETECTORS/SENSITIVITY
High energy photon response of moderated neutron detectors (Polyethylene-moderated indium activation foil with cadmium filter), 3:26820 (SLAC-PUB-1768)
MOESSBAUER EFFECT/LINE WIDTHS
Breakdown of the "white noise approximation" in the Moessbauer relaxation spectra: The case of $Cs_2NaYbCl_6$, 3:26653
MOLDS
See FUNGI
MOLECULAR FLUORESCENCE SPECTROSCOPY
See FLUORESCENCE SPECTROSCOPY
MOLECULAR ORBITAL MODEL
See ATOMIC MODELS
MOLECULES
MOLECULE-MOLECULE COLLISIONS/RESEARCH PROGRAMS
Technical progress report, 1 July 1976-30 November 1977 (Summaries of research activities at California Institute of Technology), 3:27064 (CALT-767P4-161)
MOLECULES
See also POLYATOMIC MOLECULES
MOLECULES/RESEARCH PROGRAMS
Physics Division annual review, 1 April 1976-31 March 1977 (ANL), 3:27312 (ANL-77-60)
MOLYBDENUM/CATALYTIC EFFECTS
Effects of mineral matter on the hydroliquefaction of coal, 3:25663 (SAND-77-1558C)
MOLYBDENUM/CHEMICAL VAPOR DEPOSITION
Optical properties of thin film refractory metals (Spectrally selective surfaces for solar absorbers), 3:26069
MOLYBDENUM/ELECTRIC CONDUCTIVITY
Temperature dependence of the thermal conductivity and electrical conductivity of sintered molybdenum in the low-temperature region, 3:26623
MOLYBDENUM/EMISSIVITY
Integral hemispherical degree of blackness of alloys of high-melting metals at high temperatures, 3:26622
MOLYBDENUM/ION EXCHANGE
Cation exchange of 53 elements in nitric acid, 3:26665 (LA-7083)
MOLYBDENUM/OPTICAL PROPERTIES
Optical properties of thin film refractory metals (Spectrally selective surfaces for solar absorbers), 3:26069
MOLYBDENUM/SUPERCONDUCTIVITY
Oscillations of properties of thin superconducting films with varying coating thickness, 3:26624
MOLYBDENUM/THERMAL CONDUCTIVITY
Temperature dependence of the thermal conductivity and electrical conductivity of sintered molybdenum in the low-temperature region, 3:26623
MOLYBDENUM/THERMAL EXPANSION
Features of the expansion of condensed substances acted on by high-power shock waves, 3:26613
MOLYBDENUM ALLOYS
See also STAINLESS STEEL-316
MOLYBDENUM ALLOYS/CREEP
Titanium and titanium alloy creep (a bibliography with abstracts). Report for 1964-September 1977, 3:26598 (NTIS/PS-77/0803)
MOLYBDENUM ALLOYS/EMISSIVITY
Integral hemispherical degree of blackness of alloys of high-melting metals at high temperatures, 3:26622
MOLYBDENUM FLUORIDES/MAGNETIC RESONANCE
Optical and zero field magnetic resonance spectroscopy of inorganic molecular solids. Final report, 1 June 1975-31 May 1977, 3:26645 (AD-A-043340)
MOLYBDENUM FLUORIDES/OPTICAL PROPERTIES
Optical and zero field magnetic resonance spectroscopy of inorganic molecular solids. Final report, 1 June 1975-31 May 1977, 3:26645 (AD-A-043340)

MOLYBDENUM ORES/GEOLOGY
Potassium-sodium metasomatites of a hydrothermal, uranium-molybdenum ore deposit, 3:25906
MOLYBDENUM SULFIDES/CRITICAL FIELD
Investigation of the heat capacity and of the superconducting properties of the sulfide Mo_6NaS_8, 3:26655
MOLYBDENUM SULFIDES/SPECIFIC HEAT
Investigation of the heat capacity and of the superconducting properties of the sulfide Mo_6NaS_8, 3:26655
MONITORS (FAILED ELEMENTS)
See FAILED ELEMENT MONITORS
MONITORS (REACTOR)
See REACTOR CONTROL SYSTEMS
MONTANA/ENERGY SOURCE DEVELOPMENT
Western States energy resource development update 1976, 3:26503
MUELHEIM-KAERLICH REACTOR
Muelheim-Kaerlich nuclear power plant, 3:26245
MUELHEIM-KAERLICH REACTOR/REACTOR LICENSING
Second partial licence for the erection of a nuclear power plant within the boundaries of Muelheim-Kaerlich dated 6th July 1977, 3:26251
MULTI-ELEMENT ANALYSIS/X-RAY FLUORESCENCE ANALYSIS
Automated elemental analysis using energy dispersive x-ray fluorescence analysis, 3:26879 (LBL-7211)
MULTIWIRE PROPORTIONAL CHAMBERS
See also DRIFT CHAMBERS
MULTIWIRE PROPORTIONAL CHAMBERS/READOUT SYSTEMS
1K delay line digitizer (For External Muon Identifier experiment at Fermilab), 3:26830 (LBL-7215)
MUNICIPAL WASTES
See also REFUSE DERIVED FUELS
MUNICIPAL WASTES/ANAEROBIC DIGESTION
A.S.E.F. solid waste to methane gas, Pompano Beach, Florida. Project progress report No. 22, 3:26015 (COO/2991-19)
ANFLOW treatment of municipal waste water, 3:26011 (COO/2991-19)
MUNICIPAL WASTES/COMBUSTION
Where does the garbage go, 3:26575 (DOE-tr-26)
MUNICIPAL WASTES/ENERGY SOURCES
Overcoming institutional barriers to solid waste utilization as an energy source. Final report, 3:26531 (HCP/L50172-01)
Overcoming institutional barriers to solid waste utilization as an energy source. Executive summary, 3:26532 (HCP/L50172-02)
MUNICIPAL WASTES/WASTE PROCESSING
ANFLOW treatment of municipal waste water, 3:26011 (COO/2991-19)
MUNITIONS
See ORDNANCE
MUON NEUTRINOS/DECAY
Limits on the mass of the muon neutrino in the absence of muon-lepton-number conservation, 3:27197
MUON NEUTRINOS/MASS
Limits on the mass of the muon neutrino in the absence of muon-lepton-number conservation, 3:27197
MUON PAIRS/PARTICLE PRODUCTION
Dimuon distribution from production of heavy particles in high-energy ν and nu-bar reactions, 3:27187
MUON REACTIONS/CAPTURE
Beta decays and related processes in the A = 14 nuclei, 3:27326
Charged-particle emission accompanying muon capture by nuclei, 3:27396
MUON-NUCLEON INTERACTIONS
See also MUON-PROTON INTERACTIONS
MUON-NUCLEON INTERACTIONS/DEEP INELASTIC SCATTERING
Deep inelastic electron and muon scattering (Review), 3:27169 (SLAC-PUB-1613)
Inclusive production of rho^0 in inelastic muon-nucleon scattering, 3:27102
MUON-PROTON INTERACTIONS/DEEP INELASTIC SCATTERING
Some results in μh^{+-} X process (Structure functions, charge ratio, 2 to 12 GeV), 3:27108 (SLAC-PUB-1822)
MUON-PROTON INTERACTIONS/INCLUSIVE INTERACTIONS
Clean tests of quantum chromodynamics in μp scattering, 3:27172
Some results in μh^{+-} X process (Structure functions, charge ratio, 2 to 12 GeV), 3:27108 (SLAC-PUB-1822)
MUONS
See also MUONS MINUS
MUONS PLUS
MUONS/COMPOSITE MODELS
Impact of quantum electrodynamics, 3:27255 (SLAC-PUB-1699)
MUONS/MAGNETIC MOMENTS
Contribution to the eighth-order anomalous magnetic moment of the muon, 3:27173
MUONS/PAIR PRODUCTION
Gauge theories: an introduction (Review lectures, V-A theory, intermediate vector boson model), 3:27295
MUONS MINUS/PARTICLE PRODUCTION
Observation of μe events in anti ν and ν interactions in neon, 3:27114
MUONS PLUS/PARTICLE PRODUCTION
Observation of μe events in anti ν and ν interactions in neon, 3:27114
MUSCLES
See also MYOCARDIUM
MUSCLES/PATHOLOGY
Myopathy associated with a murine Sarcocystic infection, 3:26982 (CONF-770504-)
MUTAGENS/BIBLIOGRAPHIES
Literature survey of bacterial, fungal, and Drosophila assay systems used in the evaluation of selected chemical compounds for mutagenic activity, 3:26994 (ORNL/EMIC-9)
MUTAGENS/BIOASSAY
Literature survey of bacterial, fungal, and Drosophila assay systems used in the evaluation of selected chemical compounds for mutagenic activity, 3:26994 (ORNL/EMIC-9)
MUTAGENS/BIOLOGICAL EFFECTS
Cellular heredity in haploid cultures of somatic cells. Annual progress report, April 1976-July 1977, 3:26960 (COO-3110-28)
Procedures for the detection of unscheduled DNA synthesis in the germ cells of mole mice exposed in vivo to chemical mutagens (^{3}H-dt tracer study), 3:26996 (TID-28142)
MYOCARDIUM/RADIONUCLIDE KINETICS
Investigation of ^{18}F-2-deoxyglucose for the measure of myocardial glucose metabolism, 3:26993 (UCLA-12-1142)

N

NAPHTHA/CHEMICAL COMPOSITION
Chemical composition of naphthas from coking of petroleum residues, 3:25820
NAPHTHA/CRACKING
Economics of naphthe versus gas cracking, 3:25831
NAPHTHA/DISTILLATION
Chemical composition of naphthas from coking of petroleum residues, 3:25820
NAPHTHA/GAS CHROMATOGRAPHY
Chemical composition of naphthas from coking of petroleum residues, 3:25820
NAPHTHA/REFORMER PROCESSES
Catalytic reforming of naphtha cuts over polymetallic catalysts, 3:25772
NATIONAL ACCELERATOR LABORATORY
See FERMILAB ACCELERATOR
NATIONAL ENERGY PLAN
Impacts of the national energy programme on solar economics, 3:26051 (LA-UR-78-131)
NATIONAL ENERGY PLAN/COST
Interactions among the National Energy Plan and the President's Environmental Message: the Coal Conversion Regulatory Program, 3:26516 (TID-28130)
NATIONAL ENERGY PLAN/ECONOMIC IMPACT
Prospects for solar energy: the impact of the National Energy Plan (Economic analysis of solar space heating and solar water heating by state), 3:25985 (LA-7064-MS)
NATIONAL ENERGY PLAN/ENVIRONMENTAL EFFECTS
Interactions among the National Energy Plan and the President's Environmental Message: the Coal Conversion Regulatory Program, 3:26516 (TID-28130)
NATIONAL ENERGY PLAN/REGIONAL ANALYSIS
Interactions among the National Energy Plan and the President's Environmental Message: the Coal Conversion Regulatory Program, 3:26516 (TID-28130)
NATURAL DRAFT COOLING TOWERS/CONSTRUCTION
Possible cooling tower designs and their economy, 3:26136
NATURAL DRAFT COOLING TOWERS/STRESS ANALYSIS
Risk analysis for natural-draught cooling towers under wind load, 3:26135
NATURAL DRAFT COOLING TOWERS/STRESSES
Supporting behaviour of natural-draft cooling towers under special consideration of mining influences, 3:26139
NATURAL GAS
See also LIQUEFIED NATURAL GAS
NATURAL GAS/CHARGES
Annual summary of cost and quality of electric utility plant fuels, 1976, 3:25722 (TID-28133)
Impacts of the national energy programme on solar economics, 3:26051 (LA-UR-78-131)

Prospects for solar energy: the impact of the National Energy Plan (Economic analysis of solar space heating and solar water heating by state), 3:25985 (LA-7064-MS)
NATURAL GAS/COMBUSTION PROPERTIES
Boiler burner design criteria for retrofit with low-Btu gases, 3:26778 (CONF-770885-1)
Development of combustion data to utilize low-Btu gases as industrial process fuels. Project 8985 monthly status report, November 1-November 30, 1977, 3:25712 (FE-2489-18)
NATURAL GAS/CONSUMER PROTECTION
Emergency natural gas purchases: actions needed to correct program abuses and consumer inequities, 3:25862 (EMD-78-10)
NATURAL GAS/CONSUMPTION RATES
Annual summary of cost and quality of electric utility plant fuels, 1976, 3:25722 (TID-28133)
NATURAL GAS/DEMAND FACTORS
Future market for LNG in the United States, 3:25848
NATURAL GAS/PRODUCTION
Geology and petroleum of the Mancos B formation, Douglas Creek arch area, Colorado and Utah, 3:25738
Mesaverde hydraulic fracture stimulation, northern Piceance basin: progress report, 3:25860
World natural gas: 1975, 3:25846
NATURAL GAS/PURIFICATION
Denitrogenation plant Clenze, 3:25832
NATURAL GAS/TRADE
Emergency natural gas purchases: actions needed to correct program abuses and consumer inequities, 3:25862 (EMD-78-10)
World natural gas: 1975, 3:25846
NATURAL GAS/UNDERGROUND STORAGE
Use of gamma-gamma logging in the operation of underground reservoirs for gas and petroleum products in rock salt deposits, 3:25823 (UCRL-Trans-11314)
NATURAL GAS DEPOSITS
See also GAS CONDENSATE FIELDS
Effect of thermal field on oil-gas formation in mesozoic deposits of the Western Siberian plate, 3:25728
Petroleum potential of southwestern Wyoming and adjacent areas, 3:25737
Shallow marine deposits in the Upper Cretaceous Pierre Shale of the northern Denver basin and their relation to hydrocarbon accumulation, 3:25739
NATURAL GAS DEPOSITS/EXPLORATION
Fractured shale hydrocarbon reservoirs in southern Rocky Mountain basins, 3:25734
Oil potential of Mesozoic sediments beneath the Independence Mountain thrust fault, North Park, Colorado, 3:25731
Seismic stratigraphic exploration: a new frontier, 3:25735
Structural style in relation to oil and gas exploration in North Park-Middle Park basin, Colorado, 3:25730
NATURAL GAS DEPOSITS/GEOLOGY
Geology and gas exploration potential, Upper Cretaceous and Lower Tertiary strata, northern Raton basin, Colorado, 3:25828
Regularities in the arrangement and formation conditions of zones of oil and gas accumulation in jurassic deposits of south Russia, 3:25744
NATURAL GAS DEPOSITS/GEOPRESSURED SYSTEMS
Natural gas content of geopressured aquifers, 3:25826 (CONF-771153-1)
NATURAL GAS DEPOSITS/GRAVITY SURVEYS
Experience of application of multidimensional regression analysis in connection with integrated interpretation of local gravitational anomalies of structurally complex regions of Azerbaijan, 3:25742
NATURAL GAS DEPOSITS/NEUTRON-GAMMA LOGGING
Estimation of carbonate reservoirs of East Turkmeniya from the lateral-logging and neutron-gamma logging data, 3:25829
NATURAL GAS DEPOSITS/PROSPECTING
Relations between the depth and surface tectonics of the Urals and Priurals and their significance in searching for oil and gas, 3:25727
NATURAL GAS DEPOSITS/RESISTIVITY LOGGING
Estimation of carbonate reservoirs of East Turkmeniya from the lateral-logging and neutron-gamma logging data, 3:25829
NATURAL GAS DEPOSITS/WELL LOGGING
Evaluation of porosity boundaries of reservoirs in Efremovskoye gas field, 3:25830
NATURAL GAS DISTRIBUTION SYSTEMS
See also PIPELINES
NATURAL GAS DISTRIBUTION SYSTEMS/CONSTRUCTION
Profile of the Southern Feeder, 3:25865
NATURAL GAS DISTRIBUTION SYSTEMS/LOAD MANAGEMENT
LNG peak-shaving plant at Maasvlakte, 3:25852
NATURAL GAS DISTRIBUTION SYSTEMS/MAINTENANCE
Performance of a high-pressure pulsed water-jet device for fracturing concrete pavement (For maintenance of underground utilities), 3:26704 (CONF-780409-1)
NATURAL GAS FIELDS/ENVIRONMENTAL POLICY
Policies, practices, and responsibilities for safety and environmental protection in oil and gas operations on the Outer Continental Shelf, 3:25802 (NP-22640)
NATURAL GAS FIELDS/LEASING
Outer Continental Shelf Sale No. 35: problems selecting and evaluating land to lease, 3:25806 (EMD-77-19)
NATURAL GAS FIELDS/PRODUCTIVITY
Beecher Island field, Yuma County, Colorado, 3:25833
NATURAL GAS FIELDS/SAFETY
Policies, practices, and responsibilities for safety and environmental protection in oil and gas operations on the Outer Continental Shelf, 3:25802 (NP-22640)
NATURAL GAS GATHERING SYSTEMS
See NATURAL GAS DISTRIBUTION SYSTEMS
NATURAL GAS INDUSTRY
National gas survey. Volume 1. The Commission report (Book), 3:25824
NATURAL GAS LIQUIDS
See also LIQUEFIED PETROLEUM GASES
NATURAL GAS LIQUIDS/CRACKING
Economics of naphthe versus gas cracking, 3:25831
NATURAL GAS WELLS
Beecher Island field, Yuma County, Colorado, 3:25833
NATURAL GAS WELLS/EXPLOSIVE STIMULATION
Gas flow in a permeable earth formation containing a crack (Containment), 3:26857
NATURAL GAS WELLS/HYDRAULIC FRACTURING
Application of massive hydraulic fracturing to the tight Muddy "J" Formation, Wattenberg field, Colorado, 3:25861
Mesaverde hydraulic fracture stimulation, northern Piceance basin: progress report, 3:25860
NATURAL GAS WELLS/WELL STIMULATION
Evaluation of methods for stimulation and characterzation of eastern gas shales. Progress report, April-June 1977, 3:25859 (LA-7094-PR)
NATURAL RUBBER/DECOMPOSITION
Mechanism of action on rubber by products from thermal oxidation of hydrotreated fuels, 3:25787
NATURAL RUBBER/OXIDATION
Mechanism of action on rubber by products from thermal oxidation of hydrotreated fuels, 3:25787
NEBRASKA/PETROLEUM DEPOSITS
Preliminary report: petroleum geochemistry of the Denver basin, 3:25741
NEODYMIUM COMPOUNDS/EXCITED STATES
Rare earth vapor laser studies, 3:27680 (UCRL-79364)
NEODYMIUM COMPOUNDS/KNIGHT SHIFT
Systematics in the Knight shift of rare-earth monopnictides, 3:26600
NEODYMIUM LASERS
Power lasers for thermonuclear fusion, 3:27688
NEODYMIUM LASERS/FABRICATION
Laser based on yttrium-aluminum garnet with neodymium for generating a high-power fourth harmonic in the periodic pulse mode, 3:26758
NEODYMIUM LASERS/KINETICS
Rare earth vapor laser studies, 3:27680 (UCRL-79364)
NEODYMIUM LASERS/PERFORMANCE
1.05 to 1.44 μm tunability and performance of the cw Nd^{3+}:YAG laser, 3:26742
NEODYMIUM LASERS/RESEARCH PROGRAMS
Solid-state laser program, 3:27676 (UCRL-52000-77-8)
NEODYMIUM NITRATES/THERMODYNAMIC PROPERTIES
Excess Gibbs free energy and the activity coefficients of the $Nd(NO_3)_3$-HNO_3-H_2O system at 25°C, 3:26671 (IS-M-125)
NEOMYCIN
See ANTIBIOTICS
NEON/ELECTRON-ATOM COLLISIONS
Time-of-flight spectrometer measurements of elastic-scattering cross sections for electrons with energies of 0.04-1.5 eV in He and Ne, 3:27081
NEON/HEAVY ION REACTIONS
Proton and pion spectra at large angles in relativistic heavy-ion collisions (800 MeV/N), 3:27332 (LBL-670)
NEON/ION-ATOM COLLISIONS
K-shell capture by protons from O_2, N_2, and Ne, 3:27070
NEON/PHOTOIONIZATION
Theoretical study of the photoionization of metastable neon, 3:27050
NEON 20 REACTIONS/MULTIPLE PRODUCTION
Evidence against copious threshold pion production in heavy-ion collisions, 3:27122
NEON 20 TARGET/NEUTRINO REACTIONS
Observation of μe events in anti ν and ν interactions in neon, 3:27114

NEON 22 REACTIONS/FISSION
Measurement of the effective widths of excited states of heavy nuclei (Z=98, 100, 102) by means of the blocking effect, 3:27382
NEOPLASMS
See also CARCINOMAS
MELANOMAS
NEOPLASMS/CONTROL
Genus nicotiana as a genetic resource. Chapter 1, 3:26967 (BNL-23558)
NEOPLASMS/DIAGNOSTIC TECHNIQUES
Biomedical research and application utilizing cyclotron produced radionuclides. Progress report, January 1 1977-December 31, 1977, 3:26971 (COO/4268-1)
Tumor scanning agents, 3:26973
NEOPLASMS/DOSE-RESPONSE RELATIONSHIPS
Competing risk model for reduction in life expectancy from radiogenic latent cancer (Radiation exposure as result of nuclear reactor accidents), 3:26985 (SAND-77-1352C)
NEOPLASMS/RADIOINDUCTION
Competing risk model for reduction in life expectancy from radiogenic latent cancer (Radiation exposure as result of nuclear reactor accidents), 3:26985 (SAND-77-1352C)
NET ENERGY
(Difference of energy output and energy input.)
NET ENERGY/EVALUATION
Net energy analysis: little progress and many problems, 3:26494 (EMD-77-57)
NET ENERGY/USES
Net energy analysis: little progress and many problems, 3:26494 (EMD-77-57)
NETHERLANDS/ENERGY POLICY
Energy: now and in the future (8 papers), 3:26514 (CONF-770149-)
NETHERLANDS/ENERGY SOURCES
Energy: now and in the future (8 papers), 3:26514 (CONF-770149-)
NEUROSPORA/GENE RECOMBINATION
Studies on mechanisms of mutation, recombination, and gene action in neurospora. Final report, 3:26968 (SRO-735-5)
NEUROSPORA/MUTATIONS
Studies on mechanisms of mutation, recombination, and gene action in neurospora. Final report, 3:26968 (SRO-735-5)
NEUTRAL ATOM BEAM INJECTION/ENERGY LOSSES
Neutrals escape on a wall due to charge exchange while neutral beam injection into a toroidal plasma, 3:27429 (IAE-2520)
NEUTRAL ATOM BEAM INJECTION/ION SOURCES
High energy neutral injectors based upon negative ion plasma sources, 3:26800 (BNL-23653)
NEUTRAL ATOM BEAM INJECTION/MAGNETIC FIELD CONFIGURATIONS
Magnetics design for ripple-assisted beam injection into the ISX-B and TFTR Tokamaks, 3:27592 (CONF-771029-203)
NEUTRAL ATOM BEAM INJECTION/RESEARCH PROGRAMS
Status of the LBL/LLL development program, 3:27658 (LBL-6830)
NEUTRAL ATOM BEAM INJECTION/TRAJECTORIES
Neutrals escape on a wall due to charge exchange while neutral beam injection into a toroidal plasma, 3:27429 (IAE-2520)
NEUTRAL BEAM SOURCES
See also ION SOURCES
NEUTRAL BEAM SOURCES/RESEARCH PROGRAMS
Status of the LBL/LLL development program, 3:27658 (LBL-6830)
NEUTRAL BEAM SOURCES/REVIEWS
Neutral beam injector research and development work in the USA, 3:27663
NEUTRAL CURRENTS
(Neutral currents occur in a process where a lepton scatters off another particle, does not change its charge, and a heavy neutral particle is exchanged between the lepton and the particle from which it scatters.)
See also WEAK NEUTRAL CURRENTS
NEUTRAL CURRENTS/GAUGE INVARIANCE
Gauge theories of weak interactions with left-right symmetry and the structure of neutral currents, 3:27250
NEUTRAL-PARTICLE TRANSPORT
See also NEUTRON TRANSPORT
PHOTON TRANSPORT
NEUTRAL-PARTICLE TRANSPORT/ONE-DIMENSIONAL CALCULATIONS
Numerical calculations of transport in ALCATOR, 3:27507 (PPPL-1411)
NEUTRETTOS
See MUON NEUTRINOS
NEUTRINO REACTIONS/CHARGED-CURRENT INTERACTIONS
Observation of μe events in anti ν and ν interactions in neon, 3:27114
NEUTRINO-DEUTERON INTERACTIONS/QUASI-ELASTIC SCATTERING
Neutrino interactions in hydrogen and deuterium: Description of the experiment and study of the reaction $\nu + d \rightarrow \mu^- + p + p/$ sub s/, 3:27116
NEUTRINO-ELECTRON INTERACTIONS
See also ANTINEUTRINO-ELECTRON INTERACTIONS
NEUTRINO-ELECTRON INTERACTIONS/ELASTIC SCATTERING
Gauge theories: an introduction (Review lectures, V-A theory, intermediate vector boson model), 3:27295
NEUTRINO-NUCLEON INTERACTIONS
See also ANTINEUTRINO-NUCLEON INTERACTIONS
NEUTRINO-PROTON INTERACTIONS
NEUTRINO-NUCLEON INTERACTIONS/CHARGED-CURRENT INTERACTIONS
Currents, quarks, and gluons, 3:27162
Measurements of ν/sub μ//sub N/and ν-bar/sub μ//sub N/ charged-current total cross sections, 3:27115
NEUTRINO-NUCLEON INTERACTIONS/COLOR MODEL
Currents, quarks, and gluons, 3:27162
NEUTRINO-NUCLEON INTERACTIONS/DEEP INELASTIC SCATTERING
Violation of scaling and the production of charmed particles in neutrino experiments, 3:27201
NEUTRINO-NUCLEON INTERACTIONS/GLUON MODEL
Currents, quarks, and gluons, 3:27162
NEUTRINO-NUCLEON INTERACTIONS/HEAVY LEPTONS
Electron signals from heavy-lepton cascade decays, 3:27190
NEUTRINO-NUCLEON INTERACTIONS/INCLUSIVE INTERACTIONS
Quantum chromodynamics predictions for the associated production of charm by neutrinos, 3:27186
NEUTRINO-NUCLEON INTERACTIONS/PAIR PRODUCTION
Dimuon distribution from production of heavy particles in high-energy ν and nu-bar reactions, 3:27187
Like-sign muon-electron production by neutrinos: Key to trilepton mechanisms, 3:27189
NEUTRINO-NUCLEON INTERACTIONS/PARTICLE PRODUCTION
Cascade decays of heavy leptons produced by neutrinos (Gauge SU(2) x U(1) model), 3:27195
Experimental limits on heavy lepton production by neutrinos (Mixing angle limits), 3:27106 (BNL-23513)
Search for heavy particles, 3:27184 (SLAC-PUB-1891)
NEUTRINO-NUCLEON INTERACTIONS/QUARK MODEL
Retention of quantum numbers by quark and multiquark jets, 3:27159
NEUTRINO-PROTON INTERACTIONS/QUASI-ELASTIC SCATTERING
Neutrino interactions in hydrogen and deuterium: Description of the experiment and study of the reaction $\nu + d \rightarrow \mu^- + p + p/$ sub s/, 3:27116
NEUTRINOS
See also MUON NEUTRINOS
SOLAR NEUTRINOS
NEUTRINOS/ELECTRIC CHARGES
Gauge theories: an introduction (Review lectures, V-A theory, intermediate vector boson model), 3:27295
NEUTRINOS/MAGNETIC MOMENTS
Gauge theories: an introduction (Review lectures, V-A theory, intermediate vector boson model), 3:27295
NEUTRINOS/MASS
Implications of a nonzero neutrino mass for the process $\gamma\gamma \rightarrow$ νnu-bar, 3:27200
NEUTRINOS/REVIEWS
Summary talk: neutrino '77, 3:27111 (SLAC-PUB-1996)
NEUTRINOS/WEAK INTERACTIONS
Super-gauge groups, 3:27204
NEUTRON DETECTION/BONNER SPHERE DETECTORS
Least-squares technique for extracting neutron spectra from Bonner sphere data, 3:26828
NEUTRON DETECTION/PLASTIC SCINTILLATION DETECTORS
Calibration of a detector for pulsed neutron sources, 3:26819 (LA-7022-MS)
NEUTRON DETECTORS
See also ACTIVATION DETECTORS
MODERATING DETECTORS
NEUTRON DETECTORS/RESPONSE FUNCTIONS
Photon and electron response of silicon-diode neutron detectors, 3:26822

NEUTRON DIFFRACTION/DATA ANALYSIS
Profile analysis of powder neutron diffraction data: its scope, limitations, and applications in solid state chemistry, 3:26680
NEUTRON DIFFUSION EQUATION/ANALYTICAL SOLUTION
Integral representation of the GREEN function for time-dependent processes in one-group diffusion approximation, 3:26347
NEUTRON DIFFUSION EQUATION/NUMERICAL SOLUTION
Two-group diffusion calculation through pseudo-continuous synthesis, 3:26352
NEUTRON DOSIMETRY/STANDARDS
Neutron dosimetry standard. Final report, 1 May 1974-30 October 1975, 3:27403 (AD-A-042276)
NEUTRON LOGGING/PERFORMANCE
Use of borehole geophysical methods in determining in situ bulk densities and water contents in unconsolidated materials. Final report, 3:26844 (AD-A-046114)
NEUTRON REACTIONS/CAPTURE
Statistical model radiation widths for $75 < A < 130$ and the enhancement of p-wave neutron capture for $A \cong 90$, 3:27362
NEUTRON REACTIONS/COHERENT PRODUCTION
Coherent dissociation of neutrons on nuclei at 100-300 GeV/c, 3:27123
NEUTRON REACTIONS/DIRECT REACTIONS
Equilibrium, pre-equilibrium, and direct processes in the (n,n′) reaction, 3:27354
NEUTRON REACTIONS/FISSION
Fission of ^{240}Pu with 14.8-MeV neutrons, 3:27381
NEUTRON REACTIONS/INCLUSIVE INTERACTIONS
Inclusive charged-particle production in neutron-nucleus collisions, 3:27121
NEUTRON REACTIONS/INELASTIC SCATTERING
Equilibrium, pre-equilibrium, and direct processes in the (n,n′) reaction, 3:27354
NEUTRON REACTIONS/KNOCK-OUT REACTIONS
Cross sections for (n,2n) and (n,3n) reactions above 14 MeV, 3:27353
NEUTRON REACTIONS/PRECOMPOUND-NUCLEUS EMISSION
Equilibrium, pre-equilibrium, and direct processes in the (n,n′) reaction, 3:27354
NEUTRON REACTIONS/THERMAL FISSION
Thermal-neutron fission of ^{233}U and ^{235}U accompanied by emission of α particles at small angles to the fission axis, 3:27384
NEUTRON REACTIONS/TOTAL CROSS SECTIONS
High resolution neutron total cross section measurement of ^{89}Y, 3:27366
NEUTRON SOURCES
(Excludes reactors even when used as neutron sources.)
Rotating target neutron generators, 3:26789
NEUTRON SOURCES/DESIGN
160 kV, 200 mA dc accelerator for high 14 MeV neutron yield, 3:26792
Characteristics of an intense neutron source based on the d+Be reaction, 3:26794
Intense neutron source based upon the deuterium-stripping reaction, 3:26791
Pulsed neutron generator for logging, 3:25908
NEUTRON SOURCES/PERFORMANCE
Pulsed neutron generator for logging, 3:25908
NEUTRON SOURCES/TARGETS
Compact beryllium target for production of fast neutrons, 3:26798
NEUTRON SOURCES/USES
Pulsed power applications to intense neutron source development, 3:26793
Pulsed spallation neutron sources for slow neutron scattering, 3:26790
NEUTRON SPECTRA/STANDARDS
Neutron dosimetry standard. Final report, 1 May 1974-30 October 1975, 3:27403 (AD-A-042276)
NEUTRON TRANSPORT/ENERGY LOSSES
Energy deposition rates and Compton electron currents from low-altitude bursts as a function of source energy. Interim report 17 Nov 76-1 Nov 77, 3:27042 (AD-A-046092)
NEUTRON TRANSPORT THEORY
Solution of the time-dependent multi-group neutron transport equation using spherical harmonics, 3:26353
TRIDENT: a new triangular mesh discrete ordinates code, 3:27616 (LA-UR-77-2511)
NEUTRON-NEUTRON LOGGING/NEUTRON SOURCES
Pulsed neutron generator for logging, 3:25908
NEUTRONS/STRUCTURE FUNCTIONS
Relativistic interactions in nuclei and the approach to scaling in deep inelastic scattering, 3:27390 (SLAC-203)
NEVADA/ENERGY SOURCE DEVELOPMENT
Western States energy resource development update 1976, 3:26503
NEVADA/GEOCHEMICAL SURVEYS
Chemical data and variation diagrams of igneous rocks from the Timber Mountain-Oasis Valley, Caldera Complex, southern Nevada, 3:27018 (USGS-OFR-77-724)
NEVADA/IGNEOUS ROCKS
Chemical data and variation diagrams of igneous rocks from the Timber Mountain-Oasis Valley, Caldera Complex, southern Nevada, 3:27018 (USGS-OFR-77-724)
NEVADA TEST SITE/RADIATION MONITORING
Environmental plutonium on the Nevada Test Site and environs, 3:26909 (NVO-171)
NEVADA TEST SITE/RADIONUCLIDE MIGRATION
^{239}Pu and ^{241}Am contamination of small vertebrates in NAEG study areas of NTS and TTR, 3:26915 (NVO-171)
Estimated inventory of plutonium and uranium radionuclides for vegetation in aged fallout areas, 3:26913 (NVO-171)
Plutonium distribution in a desert pavement-desert mound soil system in area 11, 3:26910 (NVO-171)
Solubility of plutonium and americium-241 from rumen contents of cattle grazing on plutonium-contaminated desert vegetation in in vitro bovine gastrointestinal fluids, November 1974-May 1975 (Uptake of transuranics by dairy cows from contaminated forage with emphasis on excretion in milk), 3:26914 (NVO-171)
NEVADA TEST SITE/SOILS
Plutonium distribution in a desert pavement-desert mound soil system in area 11, 3:26910 (NVO-171)
Plutonium distribution in the environs of the Nevada Test Site: status report, 3:26911 (NVO-171)
NEVADA TEST SITE/TERRESTRIAL ECOSYSTEMS
^{239}Pu and ^{241}Am contamination of small vertebrates in NAEG study areas of NTS and TTR, 3:26915 (NVO-171)
Environmental plutonium on the Nevada Test Site and environs, 3:26909 (NVO-171)
Initial synthesis of area 13 ^{239}Pu data and other statistical analyses (^{239}Pu and ^{240}Pu distribution in soil and biological samples from Nevada Test Site), 3:26912 (NVO-171)
Solubility of plutonium and americium-241 from rumen contents of cattle grazing on plutonium-contaminated desert vegetation in in vitro bovine gastrointestinal fluids, November 1974-May 1975 (Uptake of transuranics by dairy cows from contaminated forage with emphasis on excretion in milk), 3:26914 (NVO-171)
NEW MEXICO/ENERGY SOURCE DEVELOPMENT
Western States energy resource development update 1976, 3:26503
NEW MEXICO/NATURAL GAS DEPOSITS
Fractured shale hydrocarbon reservoirs in southern Rocky Mountain basins, 3:25734
NEW MEXICO/PETROLEUM DEPOSITS
Fractured shale hydrocarbon reservoirs in southern Rocky Mountain basins, 3:25734
NEW MEXICO/URANIUM DEPOSITS
Uranium abundance in some Precambrian and Phanerozoic rocks from New Mexico, 3:25912
Uranium deposits of the Grants mineral belt: geochemical constraints on origin, 3:25911
NEW YORK
Recommendations for enforcing and administering lighting-efficiency standards in existing public buildings in New York State. Final report, 3:26509 (HCP/M1223-1)
NEW ZEALAND/FOOD INDUSTRY
Energy use in the dairy industry (report No. 25), 3:26529 (NP-23050)
NEW ZEALAND/GAS CONDENSATE FIELDS
Gas-condensate fields of the Taranaki basin, New Zealand, 3:25825
NEW ZEALAND/GEOTHERMAL GRADIENTS
Temperature gradients within the adjacent to the North Island volcanic belt, 3:26096
NEW ZEALAND/HEAT FLOW
Temperature gradients within the adjacent to the North Island volcanic belt, 3:26096
NEWFOUNDLAND/OIL WELLS
Geology of the Amoco Imp Skelly A-1 Osprey H-84 well, Grand Banks, Newfoundland, 3:25743
NICKEL/EMISSION SPECTROSCOPY
Determination of trace elements in soft, hard, and saline waters by the inductively coupled plasma, multi-element atomic emission spectroscopic (ICP-MAES) technique, 3:26664
NICKEL/HYPERFINE STRUCTURE
Self-consistent screening of a positive muon in a spin-polarized electron gas, 3:26604
NICKEL/INTERSTITIALS
Self-consistent screening of a positive muon in a spin-polarized electron gas, 3:26604
NICKEL/ION COLLISIONS
Role of K-shell vacancies in determining charge-state fractions for heavy ions emerging from solids, 3:27077
NICKEL/ION EXCHANGE
Cation exchange of 53 elements in nitric acid, 3:26665 (LA-7083)

NICKEL/THERMAL EXPANSION
Measurement of the thermal expansion coefficient of nickel from 300 to 1000 K and determination of the power-law constants near the Curie temperature, 3:26609
NICKEL 58/HYPERNUCLEI
Possibility of charmed hypernuclei, 3:27228
NICKEL 58 TARGET/PION PLUS REACTIONS
Properties of inclusive (π^+,π^0) reactions in nuclei, 3:27334
NICKEL 58 TARGET/PROTON REACTIONS
Elastic scattering of 1-GeV protons by nuclei, 3:27127
NICKEL 60/GIANT RESONANCE
Investigation of giant multipole resonances in medium and heavy nuclei by inelastic electron scattering. Final technical report, 15 October 1974-31 October 1976, 3:27356 (AD-A-042298)
NICKEL 60 TARGET/CARBON 12 REACTIONS
High-spin states in ^{70}Ge, 3:27358
NICKEL 60 TARGET/ELECTRON REACTIONS
Investigation of giant multipole resonances in medium and heavy nuclei by inelastic electron scattering. Final technical report, 15 October 1974-31 October 1976, 3:27356 (AD-A-042298)
NICKEL 62 TARGET/PION MINUS REACTIONS
Energetic charged particle yields induced by pions on complex nuclei (π^{+-} on ^{27}Al, ^{62}Ni, ^{181}Ta, 100 and 220 MeV: cross sections), 3:27360 (ANL-77-60)
Gamma rays from pion-induced reactions (^{62}Ni + π^-, 220 MeV: cross sections), 3:27359 (ANL-77-60)
Study of pion-absorption mechanisms in ^{4}He and other nuclei, 3:27323
NICKEL 62 TARGET/PION PLUS REACTIONS
Energetic charged particle yields induced by pions on complex nuclei (π^{+-} on ^{27}Al, ^{62}Ni, ^{181}Ta, 100 and 220 MeV: cross sections), 3:27360 (ANL-77-60)
Study of pion-absorption mechanisms in ^{4}He and other nuclei, 3:27323
NICKEL ALLOYS/SPIN WAVES
High-temperature spin dynamics in an amorphous ferromagnet, 3:26603
NICKEL OXIDES/ELECTROPLATING
Improved black nickel coatings for flat plate solar collectors, 3:26072
NICKEL OXIDES/OPTICAL PROPERTIES
Improved black nickel coatings for flat plate solar collectors, 3:26072
NICKEL-ZINC BATTERIES/RESEARCH PROGRAMS
Federal battery program for transportation uses, 3:26485 (CONF-7606127-1)
NICOTIANA/TAXONOMY
Genus nicotiana as a genetic resource. Chapter 1, 3:26967 (BNL-23558)
NIOBIUM/ELECTRIC CONDUCTIVITY
Electrical resistance of niobium in the temperature range 200-2700°K, 3:26621
NIOBIUM/ELECTRONIC STRUCTURE
Electron-phonon spectral function and mass enhancement of niobium, 3:26611
NIOBIUM/ION EXCHANGE
Cation exchange of 53 elements in nitric acid, 3:26665 (LA-7083)
NIOBIUM/THERMAL EXPANSION
Experimental investigation of thermal expansion of a number of construction materials, niobium, and niobium alloy 5VMTs1, 3:26618
NIOBIUM 93 TARGET/NEUTRON REACTIONS
Cross sections for (n,2n) and (n,3n) reactions above 14 MeV, 3:27353
Equilibrium, pre-equilibrium, and direct processes in the (n,n') reaction, 3:27354
NIOBIUM 93 TARGET/PROTON REACTIONS
Anomalous optical-model potential for sub-Coulomb protons for $89 < A < 130$, 3:27361
NIOBIUM ALLOYS
See also INCONEL 600
NIOBIUM BASE ALLOYS
NIOBIUM ALLOYS/SUPERCONDUCTIVITY
Estimate of density-of-states changes with disorder in A-15 superconductors, 3:26602
NIOBIUM ALLOYS/THERMAL EXPANSION
Experimental investigation of thermal expansion of a number of construction materials, niobium, and niobium alloy 5VMTs1, 3:26618
NIOBIUM BASE ALLOYS/REFLECTIVITY
Thermomodulation spectra of the superconducting alloy $Nb_3(AlSi)$, 3:26626
NIOBIUM BASE ALLOYS/SUPERCONDUCTIVITY
Thermomodulation spectra of the superconducting alloy $Nb_3(AlSi)$, 3:26626
NIOBIUM CARBIDES/SPECIFIC HEAT
Thermophysical properties of cubic carbides of zirconium and niobium at high temperatures, 3:26615
NIOBIUM CARBIDES/THERMAL DIFFUSIVITY
Thermophysical properties of cubic carbides of zirconium and niobium at high temperatures, 3:26615
NIOBIUM SELENIDES/SUPERCONDUCTIVITY
Superconducting- and normal-state thermal conductivity of $NbSe_2$, 3:26654
NIOBIUM SELENIDES/THERMAL CONDUCTIVITY
Superconducting- and normal-state thermal conductivity of $NbSe_2$, 3:26654
NITRIC OXIDE/DECOMPOSITION
Decomposition rate of nitric oxide on alumina surface in the temperature range 920 to 1220°K, 3:26679
NITRIDES/KNIGHT SHIFT
Systematics in the Knight shift of rare-earth monopnictides, 3:26600
NITROGEN/DENSITY
Roscoe manual. Volume 14B. Midlatitude density profiles of selected atmospheric species. Final report, 2 March 1974-28 February 1975, 3:26852 (AD-A-043499)
NITROGEN/ION-MOLECULE COLLISIONS
K-shell capture by protons from O_2, N_2, and Ne, 3:27070
NITROGEN/PHOTON-MOLECULE COLLISIONS
Photoabsorption in molecular nitrogen: A moment analysis of discrete-basis-set calculations in the static-exchange approximation, 3:27084
NITROGEN/REMOVAL
Catalyst development for coal liquefaction. Annual report, July 1, 1976-June 30, 1977, 3:25657 (FE-2335-13)
Clean solid and liquid fuels from coal. Quarterly progress report, July-September 1977, 3:25665 (TID-28167)
Denitrogenation plant Clenze, 3:25832
NITROGEN 14 REACTIONS/COMPOUND-NUCLEUS REACTIONS
High-spin states in $A \cong 40$ nuclei: Data for ^{38}Ar and ^{39}K, 3:27346
NITROGEN 14 REACTIONS/ELASTIC SCATTERING
Low energy elastic scattering from ^{28}Si targets using projectiles with $9 < \text{or} = A < \text{or} = 18$, 3:27344
NITROGEN 14 TARGET/CARBON 12 REACTIONS
Mechanisms for Li and Be production in the $^{14}N + {}^{12}C$ reaction, 3:27336
NITROGEN 14 TARGET/MUON REACTIONS
Beta decays and related processes in the $A = 14$ nuclei, 3:27326
NITROGEN COMPOUNDS/SYNTHESIS
Laser synthetic chemistry (SF_5NF_2), 3:26692 (LA-UR-77-2790)
NITROGEN DIOXIDE/FLUORESCENCE SPECTROSCOPY
Laser spectroscopy for continuous combustion applications, 3:26700 (BMI-1982)
NITROGEN DIOXIDE/RAMAN SPECTRA
Laser spectroscopy for continuous combustion applications, 3:26700 (BMI-1982)
NITROGEN OXIDES
See also NITRIC OXIDE
NITROGEN DIOXIDE
NITROUS OXIDE
NITROGEN OXIDES/ABSORPTION SPECTRA
Experimental study of the optical absorption cross sections of nitrogen dioxide, 3:27059 (LA-tr-78-1)
NITROGEN OXIDES/AIR POLLUTION CONTROL
Influence of exhaust gas recirculation on the formation of nitrogen oxides during the burning of oil, 3:26195
NITROGEN OXIDES/DENSITY
Roscoe manual. Volume 14B. Midlatitude density profiles of selected atmospheric species. Final report, 2 March 1974-28 February 1975, 3:26852 (AD-A-043499)
NITROGEN OXIDES/ECOLOGICAL CONCENTRATION
Analysis of random errors in air-quality measurements. Final report, 3:26881 (PB-270555)
NITROGEN OXIDES/POINT POLLUTANT SOURCES
Source assessment: pressed and blown glass manufacturing plants. Final task report Sep 75-Jan 77, 3:26882 (PB-273788)
NITROGEN OXIDES/REMOVAL
Studies on nitrogen oxides removal from flue gas (No. 2), 3:26196
NITROMETHANE/DETONATIONS
Thermal ignition time for homogeneous explosives involving two parallel , 3:26847
NITROUS OXIDE/ECOLOGICAL CONCENTRATION
Analysis of random errors in air-quality measurements. Final report, 3:26881 (PB-270555)
NONAXIAL NUCLEI
See DEFORMED NUCLEI
NON-EQUILIBRIUM PLASMA/ELECTROMAGNETIC RADIATION
Negative absorption in an anisotropic plasma, 3:27589
NORTH SEA/MINERAL CYCLING
Distribution of some chemical elements between dissolved and particulate phases in the ocean. Period covered: August 1, 1976-October 31, 1977 (Natural ^{210}Pb and ^{210}Po tracers), 3:26930 (COO-3566-19)

NORTHERN IRELAND
See UNITED KINGDOM
NOZZLES/CRACKS
Boiling Water Reactor feedwater nozzle/sparger interim program report. Supplement No. 2: fracture mechanic analysis of JAERI model pressure vessel test, 3:26437 (NEDO-21480-02)
NOZZLES/DESIGN
Free expansion nozzle for gas dynamic lasers, 3:26753
NSRR REACTOR/IRRADIATION CAPSULES
Modification of reactor (reactor safety research facility) in Tokai Research Establishment of Japan Atomic Energy Research Institute (report), 3:26427
NUCLEAR ACCIDENTS
See ACCIDENTS
NUCLEAR EMULSIONS/NEON 20 REACTIONS
Evidence against copious threshold pion production in heavy-ion collisions, 3:27122
NUCLEAR EMULSIONS/PROTON REACTIONS
Search for a new short-lived particle in collisions of 70 GeV/c protons with emulsion nuclei, 3:27118
NUCLEAR ENGINEERING
Nuclear engineering, 3:26343
NUCLEAR ENGINEERING/STANDARDIZATION
Standardization in nuclear engineering, 3:26342
NUCLEAR EXPLOSION DETECTION/SEISMIC DETECTION
Explosion yield verification, multiple explosion scenarios and three-dimensional seismic modeling research. Quarterly technical report, 1 May-31 July 1976, 3:26863 (AD-A-043386)
NUCLEAR EXPLOSION DETECTION/SEISMIC WAVES
Interim report on phase I expansion of the seismic communication and control processor system (CCP). Technical report, 30 June-31 December 1976, 3:26862 (AD-A-042632)
Multiple seismic events, 3:26861 (AD-A-042571)
Vela network evaluation and automatic processing research. Final report, 1 July 1975-30 October 1976, 3:26860 (AD-A-042275)
NUCLEAR EXPLOSIONS
See also CANNIKIN EVENT
MILROW EVENT
UNDERGROUND EXPLOSIONS
Laboratory investigation of infrared fluorescence of CO_2, HAES report number 60. Final report 1 AGusut 1975-31 December 1976, 3:26853 (AD-A-043524)
NUCLEAR EXPLOSIONS/ATMOSPHERIC EXPLOSIONS
Effect of a cylindrically-symmetric ionospheric disturbance on elf propagation in the earth-ionosphere waveguide. Topical report, 3:27043 (AD-A-046237)
Project STRESS satellite communication test results. Final technical report, June 1976-March 1977, 3:27041 (AD-A-043873)
ROSCOE manual. Volume 16. High-altitude neutral-particle motion. Final report, 1 March 1974-31 January 1975 (> 90 km), 3:27039 (AD-A-043546)
ROSCOE manual. Volume 17. High-altitude debris-energy deposition. Final report, 1 March 1974-31 January 1975, 3:27040 (AD-A-043547)
NUCLEAR EXPLOSIONS/BIBLIOGRAPHIES
Bibliography of published material related to the Soviet PNE Program, 3:26856 (UCRL-52362)
NUCLEAR EXPLOSIONS/CONTAINMENT
Gas flow in a permeable earth formation containing a crack, 3:26857
Laboratory investigation of stemming and containment in underground nuclear tests. Final report, 3:26849 (AD-A-042547)
NUCLEAR EXPLOSIONS/ENVIRONMENTAL EFFECTS
Ecological consequences of nuclear testing, 3:26907 (TID-26712)
Environment of Amchitka Island, Alaska, 3:26895 (TID-26712)
Hydrology, 3:26896 (TID-26712)
Limnology, 3:26923 (TID-26712)
NUCLEAR EXPLOSIONS/FALLOUT
Roscoe manual. Volume 14B. Midlatitude density profiles of selected atmospheric species. Final report, 2 March 1974-28 February 1975, 3:26852 (AD-A-043499)
NUCLEAR EXPLOSIONS/NEUTRON TRANSPORT
Energy deposition rates and Compton electron currents from low-altitude bursts as a function of source energy. Interim report 17 Nov 76-1 Nov 77, 3:27042 (AD-A-046092)
NUCLEAR EXPLOSIONS/PHOTON TRANSPORT
Energy deposition rates and Compton electron currents from low-altitude bursts as a function of source energy. Interim report 17 Nov 76-1 Nov 77, 3:27042 (AD-A-046092)
NUCLEAR EXPLOSIONS/SEISMIC WAVES
Seismic studies for improved yield determination. Quarterly technical report, 1 January-31 March 1977, 3:26864 (AD-A-043389)
Simulation and decomposition of multiple explosions. Topical report, 3:26865 (AD-A-043390)
Theoretical body and surface wave magnitudes for twelve numerically simulated cratering explosions. Topical report, 3:26850 (AD-A-043387)
NUCLEAR EXPLOSIONS/SIMULATION
Characteristics of late-time striations observed during operation stress, 3:27044 (LA-UR-77-2835)
NUCLEAR EXPLOSIONS/TESTING
Laboratory investigation of rock cavity reinforcement. Final report, 17 September 1974-16 March 1976, 3:26851 (AD-A-043398)
NUCLEAR EXPLOSIONS/USES
Bibliography of published material related to the Soviet PNE Program, 3:26856 (UCRL-52362)
NUCLEAR EXPLOSIONS/YIELDS
Explosion yield verification, multiple explosion scenarios and three-dimensional seismic modeling research. Quarterly technical report, 1 May-31 July 1976, 3:26863 (AD-A-043386)
Seismic studies for improved yield determination. Quarterly technical report, 1 January-31 March 1977, 3:26864 (AD-A-043389)
Simulation and decomposition of multiple explosions. Topical report, 3:26865 (AD-A-043390)
NUCLEAR FACILITIES
See also ISOTOPE SEPARATION PLANTS
NUCLEAR FACILITIES/CHEMICAL EFFLUENTS
Assessment methodology for chemical effluents, 3:26874 (BNWL-2219)
Environmental assessment methodology for the nuclear fuel cycle, 3:26873 (BNWL-2219)
NUCLEAR FACILITIES/ENVIRONMENTAL EFFECTS
Assessment methodology for chemical effluents, 3:26874 (BNWL-2219)
NUCLEAR FACILITIES/FUEL CYCLE
Environmental assessment methodology for the nuclear fuel cycle, 3:26873 (BNWL-2219)
NUCLEAR FACILITIES/NUCLEAR MATERIALS MANAGEMENT
Regional nuclear fuel cycle centres. IAEA study project, 3:25955
NUCLEAR FACILITIES/RADIOACTIVE EFFLUENTS
Environmental assessment methodology for the nuclear fuel cycle, 3:26873 (BNWL-2219)
NUCLEAR FACILITIES/RADIOACTIVE WASTE PROCESSING
Evolution of radwaste evaporators in West Germany, 3:25932
NUCLEAR FUEL RECOVERY AND RECYCLING CENTER/RADIATION MONITORING
Environmental report No. 22, January-June 1977, 3:26889 (NP-22643)
NUCLEAR FUELS
See also FUEL ELEMENTS
FUEL SLURRIES
NUCLEAR FUELS/ALLOCATIONS
Allocation of uranium enrichment services to fuel foreign and domestic nuclear reactors, 3:25915 (ID-75-45)
NUCLEAR FUELS/BREEDING
Conserving uranium without the fast breeder, 3:26506
NUCLEAR FUELS/RESERVES
Cost of energy over the next decade, 3:26499
NUCLEAR MATERIALS MANAGEMENT
Viewpoints on key issues and evaluation criteria for assessing the potential of alternative nuclear energy systems for improving proliferation resistance, 3:26332 (TID-28078)
NUCLEAR MATERIALS MANAGEMENT/ACCOUNTING
Joint ANSI-INMM 8.1: Nuclear Regulatory Commission study of uranium hexafluoride cylinder material accountability bulk measurements, 3:25953 (RFP-2634)
NUCLEAR PHYSICS/INFORMATION NEEDS
Panel on reference nuclear data and surveys of reference data requirements, 3:27313 (BNL-NCS-50717)
NUCLEAR PHYSICS/RESEARCH PROGRAMS
Physics Division annual review, 1 April 1976-31 March 1977 (ANL), 3:27312 (ANL-77-60)
NUCLEAR POWER
Nuclear power. Its development in the United Kingdom, 3:26206
Swedish nuclear power industry. A survey, 3:26335
NUCLEAR POWER/BIBLIOGRAPHIES
Current papers in nuclear energy, 3:26344
NUCLEAR POWER/COORDINATED RESEARCH PROGRAMS
Energy research program of the Federal Republic of Germany, 3:26341
NUCLEAR POWER/ECONOMIC IMPACT
ETA-MACRO: a model of energy-economy interactions (Simulates market economy through dynamic nonlinear optimization process), 3:26497 (EPRI-EA-592)
NUCLEAR POWER/ENERGY POLICY
Viewpoints on key issues and evaluation criteria for assessing the potential of alternative nuclear energy systems for improving proliferation resistance, 3:26332 (TID-28078)
NUCLEAR POWER/GOVERNMENT POLICIES
Sunningdale seminar on nuclear policy: a summary of the discussions, 3:26333

NUCLEAR POWER/HAZARDS
Risk assessment and the social response to nuclear power, 3:26416
NUCLEAR POWER/NUCLEAR MATERIALS MANAGEMENT
Viewpoints on key issues and evaluation criteria for assessing the potential of alternative nuclear energy systems for improving proliferation resistance, 3:26332 (TID-28078)
NUCLEAR POWER/PUBLIC RELATIONS
Nuclear power in western society, 3:26415
Nuclear power is not only necessary, but it can also be mastered. EGM talk with Guido Brunner, 3:26450
Nuclear put into questions, 3:26417
Politics and engineering in nuclear-energy installations, 3:26465
Risk assessment and the social response to nuclear power, 3:26416
NUCLEAR POWER/RISK ASSESSMENT
How safe is nuclear power, 3:26451
Nuclear power - a report on progress, 3:26452
NUCLEAR POWER/TECHNOLOGY ASSESSMENT
ETA-MACRO: a model of energy-economy interactions (Simulates market economy through dynamic nonlinear optimization process), 3:26497 (EPRI-EA-592)
NUCLEAR POWER PLANTS
Nuclear power. Analyses and prognoses, 3:26337
NUCLEAR POWER PLANTS/AIR FILTERS
Long term performance of charcoal absorbers removing radioiodine in ventilation exhaust air. Final report, 3:26356 (EPRI-NP-534)
NUCLEAR POWER PLANTS/BUILDINGS
Determination of floor response spectra on the basis of the response spectrum method, 3:26449
Equivalent modal response method for seismic design of structures, 3:26454
Probable simultaneous response by the response spectrum method of analysis, 3:26455
Steady-state stresses in concrete structures subjected to sustained and cyclically varying temperatures, 3:26363
NUCLEAR POWER PLANTS/CHEMICAL EFFLUENTS
Comparative effects of coal and nuclear fuel on mortality, 3:26871 (BNL-23579)
NUCLEAR POWER PLANTS/COMPARATIVE EVALUATIONS
Impact on the employment situation of the construction and operation of power plants, 3:26500
NUCLEAR POWER PLANTS/CONSTRUCTION
Civil engineering work, 3:26205
Civil engineering construction in conventional thermal power stations and nuclear power stations, 3:26204
Delays in nuclear power plant construction. Volume I. Final report, 3:26202 (COO/4121-2(Vol.1))
Nuclear power plants. Construction status report, data as of December 31, 1977 (USA), 3:26210 (NUREG-0030-78/01)
NUCLEAR POWER PLANTS/CONTAINMENT BUILDINGS
Process and device of leak testing of works, especially concrete works (Patent), 3:26386
NUCLEAR POWER PLANTS/CONTAINMENT SHELLS
Steady-state stresses in concrete structures subjected to sustained and cyclically varying temperatures, 3:26363
NUCLEAR POWER PLANTS/COST
User's instructions for preliminary version of the CONCEPT-5 computer code (For cost estimation of coal-fired and nuclear power plants, in FORTRAN for IBM 360/95), 3:26190 (ORNL/TM-6230)
NUCLEAR POWER PLANTS/DISTRICT HEATING
Principles of nuclear district heating, 3:26544
NUCLEAR POWER PLANTS/ELECTRIC CABLES
Foil shielded flexible conduit (Patent), 3:26364
NUCLEAR POWER PLANTS/ENVIRONMENT
Validity and design of environmental surveillance systems for operating nuclear power plants. Final report, 3:26412 (EPRI-NP-604)
NUCLEAR POWER PLANTS/FAULT TREE ANALYSIS
New methodology for the computer-aided construction of fault trees, 3:26472
NUCLEAR POWER PLANTS/FEEDWATER
Mixed-bed system with outer regeneration, 3:26373
NUCLEAR POWER PLANTS/FOUNDATIONS
Rubber mounts insulate whole reactor from 0.6 g earthquakes, 3:26459
NUCLEAR POWER PLANTS/HAZARDS
Risk assessment in the absence of complete data, 3:26453
NUCLEAR POWER PLANTS/HEALTH HAZARDS
Population hazards associated with fossil fuel and nuclear power production, 3:26419
NUCLEAR POWER PLANTS/HEAT EXCHANGERS
Process and arrangements for removing a tube from a tube plate (Patent), 3:26379
NUCLEAR POWER PLANTS/MECHANICAL STRUCTURES
Structural reliability methodology: application at the system level, 3:26435 (GEFR-SP-049)
NUCLEAR POWER PLANTS/NUCLEAR MATERIALS MANAGEMENT
Viewpoints on key issues and evaluation criteria for assessing the potential of alternative nuclear energy systems for improving proliferation resistance, 3:26332 (TID-28078)
NUCLEAR POWER PLANTS/PERSONNEL
Occupational doses in the Ontario Hydro nuclear power program, 3:26463
NUCLEAR POWER PLANTS/PERSONNEL DOSIMETRY
Occupational doses in the Ontario Hydro nuclear power program, 3:26463
NUCLEAR POWER PLANTS/PERSONNEL MONITORING
Personnel monitoring by process computers in nuclear power stations, 3:26461
NUCLEAR POWER PLANTS/PIPE FITTINGS
Pipe connection for high pressure and temperature loads (Patent), 3:26382
NUCLEAR POWER PLANTS/PIPES
Reflections on the assumption of pipe breaks in order to improve safety in nuclear power plants, 3:26464
NUCLEAR POWER PLANTS/PLANNING
Delays in nuclear power plant construction. Volume I. Final report, 3:26202 (COO/4121-2(Vol.1))
NUCLEAR POWER PLANTS/RADIOACTIVE EFFLUENTS
Comparative effects of coal and nuclear fuel on mortality, 3:26871 (BNL-23579)
Plant for decanting strongly radioactive resins in waste containers (Patent), 3:25924
Population dose commitments due to radioactive releases from nuclear power plant sites in 1975, 3:26992 (PNL-2439)
Procedure for purifying a filter column (Patent), 3:25929
NUCLEAR POWER PLANTS/RADIOACTIVE WASTE DISPOSAL
Development of an installation for safe disposal of concentrated liquid radioactive wastes of nuclear power plants, 3:25927
NUCLEAR POWER PLANTS/RADIOACTIVE WASTE PROCESSING
Development of an installation for safe disposal of concentrated liquid radioactive wastes of nuclear power plants, 3:25927
Evolution of radwaste evaporators in West Germany, 3:25932
Procedure for purifying a filter column (Patent), 3:25929
NUCLEAR POWER PLANTS/REACTOR COMPONENTS
Modelling the time dependent nature of structural reliability, 3:26357 (GEFR-SP-050)
NUCLEAR POWER PLANTS/REACTOR OPERATION
Licensed operating reactors. Operating units status report, data as of 12-31-77 (USA), 3:26209 (NUREG-0020(Vol.2)(No.1))
Results of German nuclear power plant operation 1976. Pt. 2. From the annual report of the ABE board of the Deutsches Atomforum, 3:26203
NUCLEAR POWER PLANTS/REACTOR PROTECTION SYSTEMS
Protection of nuclear power plants against seismic events. Pt. 5. Seismic instrumentation, 3:26473
Reactor protection system and supervision of protection equipment, 3:26456
NUCLEAR POWER PLANTS/REACTOR SAFETY
Safety of nuclear power plants, 3:26466
NUCLEAR POWER PLANTS/REACTOR VESSELS
Steady-state stresses in concrete structures subjected to sustained and cyclically varying temperatures, 3:26363
NUCLEAR POWER PLANTS/SEISMIC DETECTION
Protection of nuclear power plants against seismic events. Pt. 5. Seismic instrumentation, 3:26473
NUCLEAR POWER PLANTS/SEISMIC EFFECTS
Stress of structures caused by earthquakes according to calculation and measurement, 3:26469
NUCLEAR POWER PLANTS/SITE SELECTION
Comments on the consequences of the setting up of a nuclear power plant, 3:26941
NUCLEAR POWER PLANTS/SOCIAL IMPACT
Impact on the employment situation of the construction and operation of power plants, 3:26500
NUCLEAR POWER PLANTS/STANDARDS
RDT Standards index, 3:26331 (RDT-INDEX-(1-78))
NUCLEAR POWER PLANTS/STEAM SYSTEMS
Nuclear power plant with a heat exchanger serving as steam generator (Patent), 3:26480
NUCLEAR POWER PLANTS/STEAM TURBINES
Steam turbines, 3:26367
NUCLEAR POWER PLANTS/THERMAL EFFLUENTS
Phenomenological models for prediction of water temperatures due to thermal-electric power plant heated discharges. Final report, 3:26935 (PB-273468)
NUCLEAR POWER PLANTS/VALVES
Fittings in energy engineering, 3:26368
NUCLEAR POWER PLANTS/WASTE HEAT UTILIZATION
Agricultural use of heat discharge by nuclear power plants, 3:26420

NUCLEAR POWER PLANTS/WATER REQUIREMENTS
Water consumption by nuclear powerplants and some hydrological implications, 3:26413 (USGS-CIRC-745)
NUCLEAR REACTIONS
See also ALPHA REACTIONS
CARBON 12 REACTIONS
DEUTERON REACTIONS
ELECTRON REACTIONS
HADRON REACTIONS
HEAVY ION REACTIONS
HELIUM 3 REACTIONS
LEPTON REACTIONS
LITHIUM 7 REACTIONS
MUON REACTIONS
NEON 20 REACTIONS
NEON 22 REACTIONS
NEUTRINO REACTIONS
NEUTRON REACTIONS
NITROGEN 14 REACTIONS
OXYGEN 16 REACTIONS
OXYGEN 18 REACTIONS
PHOTONUCLEAR REACTIONS
PION REACTIONS
PROTON REACTIONS
SPONTANEOUS FISSION
THERMONUCLEAR REACTIONS
TRITON REACTIONS
NUCLEAR REACTIONS/CENTRAL POTENTIAL
Nuclear collisions at very high energy, 3:27147 (LBL-6597)
NUCLEAR REACTIONS/DEEP INELASTIC SCATTERING
Relativistic interactions in nuclei and the approach to scaling in deep inelastic scattering (Cross sections, nucleon-nucleon force), 3:27390 (SLAC-203)
NUCLEAR REACTIONS/ELASTIC SCATTERING
Allowance for higher orders of the nuclear-surface deformation in calculations of elastic and inelastic nuclear form factors, 3:27395
NUCLEAR REACTIONS/INCLUSIVE INTERACTIONS
Relativistic interactions in nuclei and the approach to scaling in deep inelastic scattering (Cross sections, nucleon-nucleon force), 3:27390 (SLAC-203)
NUCLEAR REACTIONS/INELASTIC SCATTERING
Allowance for higher orders of the nuclear-surface deformation in calculations of elastic and inelastic nuclear form factors, 3:27395
NUCLEAR REACTORS
See REACTORS
NUCLEAR SAFETY RESEARCH REACTOR
See NSRR REACTOR
NUCLEAR WEAPON TESTS
See NUCLEAR EXPLOSIONS
NUCLEAR WEAPONS/FALLOUT
Rainout, 3:26886 (AD-A-046201)
NUCLEAR WEAPONS/SIMULATION
Event dice throw, mobility experiments. Final report (Cratering explosions as barrier to movement of military vehicles), 3:26858 (AD-A-046146)
NUCLEAR WEAPONS/STATIC LOADS
B77 GTU-8D full scale static load test of thinned wall titanium afterbody: SLL test No. 7411-3, 3:26859 (SAND-77-8291)
NUCLEATE BOILING/TRANSFER FUNCTIONS
Dynamics of nucleate region flow boiling, 3:26348
NUCLEI
See also DEFORMED NUCLEI
HYPERNUCLEI
INTERMEDIATE MASS NUCLEI
LIGHT NUCLEI
NUCLEI/SLOWING-DOWN
Coherent excitation of nuclei and atoms on passing through a crystal. Effect of slowing down, 3:27402
NUCLEI (CELLS)
See CELL NUCLEI
NUCLEON-NUCLEON INTERACTIONS
See also PROTON-PROTON INTERACTIONS
NUCLEON-NUCLEON INTERACTIONS/ELASTIC SCATTERING
Dynamics of N-N total cross sections at medium energies, 3:27227
NUCLEON-NUCLEON INTERACTIONS/INELASTIC SCATTERING
Dynamics of N-N total cross sections at medium energies, 3:27227
NUCLEON-NUCLEON INTERACTIONS/TOTAL CROSS SECTIONS
Dynamics of N-N total cross sections at medium energies, 3:27227
NUTRIENTS/ENVIRONMENTAL TRANSPORT
Energy flow and mineral cycling mechanisms, 3:25947 (PNL-2253)
NUTS
See FASTENERS

O

OAK RIDGE GASEOUS DIFFUSION PLANT
See ORGDP
OAK RIDGE RESEARCH REACTOR
See ORR REACTOR
OBESITY
See METABOLIC DISEASES
OCCIDENTAL FLASH PYROLYSIS PROCESS/PROCESS DEVELOPMENT UNITS
Flash pyrolysis coal liquefaction process development. Monthly report, July 1977, 3:25654 (FE-2244-15)
OCEAN THERMAL POWER PLANTS/EVAPORATORS
Dynamic models of falling film evaporators for ocean thermal energy conversion plants, 3:26040 (COO/2641-3)
OCEAN THERMAL POWER PLANTS/SITE SELECTION
Ocean thermal energy conversion: resource, ecological and environmental studies. Final technical report, 3:26041 (PB-269283)
OCEANOGRAPHY
Energy and the climate, 3:26868 (ORAU/IEA(M)-75-3)
OCEANS
See SEAS
OCTUPOLAR CONFIGURATIONS/ICR HEATING
Ion cyclotron resonance heating in the Wisconsin supported toroidal octupole, 3:27450
OECD
(Organization of Economic Co-operation and Development.)
OECD/ENERGY CONSUMPTION
International energy trends: 3rd quarter 1977 and recent trends, 3:26528 (NP-23033)
OFFICE BUILDINGS/LIGHTING SYSTEMS
Recommendations for enforcing and administering lighting-efficiency standards in existing public buildings in New York State. Final report, 3:26509 (HCP/M1223-1)
OFFICE BUILDINGS/RETROFITTING
Energy conservation retrofit process for existing public and institutional facilities, 3:26510
OFF-PEAK ENERGY STORAGE/ELECTRIC BATTERIES
Batteries for utility load leveling, 3:26486
OFF-PEAK ENERGY STORAGE/SODIUM-SULFUR BATTERIES
European developments in the Na/S high- temperature battery for automobile propulsion and energy storage, 3:26487 (AD-A-042541)
OFFSHORE PLATFORMS/BIBLIOGRAPHIES
Offshore structures (a bibliography with abstracts). Report for 1964-July 1977, 3:26783 (NTIS/PS-77/0716)
OFFSHORE PLATFORMS/CONSTRUCTION
Ice platforms for offshore drilling, 3:25827
OFFSHORE PLATFORMS/CONTROL EQUIPMENT
Experience with instrument systems on North Sea oil and gas production platforms, 3:25748
OFFSHORE PLATFORMS/CONTROL SYSTEMS
Some problems in installing, commissioning and maintaining instrument systems in an offshore environment, 3:26784
OFFSHORE PLATFORMS/MONITORING
Offshore platform NDT instrumentation requirements, 3:25749
OFFSHORE PLATFORMS/NONDESTRUCTIVE TESTING
Offshore platform NDT instrumentation requirements, 3:25749
OIL FIELDS/ENVIRONMENTAL POLICY
Policies, practices, and responsibilities for safety and environmental protection in oil and gas operations on the Outer Continental Shelf, 3:25802 (NP-22640)
OIL FIELDS/LEASING
Outer Continental Shelf Sale No. 35: problems selecting and evaluating land to lease, 3:25806 (EMD-77-19)
OIL FIELDS/OPERATION
Self-alignment in thrust bearings, 3:25760
OIL FIELDS/SAFETY
Policies, practices, and responsibilities for safety and environmental protection in oil and gas operations on the Outer Continental Shelf, 3:25802 (NP-22640)
OIL POLLUTION CONTAINMENT/BIBLIOGRAPHIES
Oil spill removal techniques and equipment (a bibliography with abstracts). Report for 1965-September 1977, 3:25803 (NTIS/PS-77/0750)
OIL RETENTION BOOMS/DESIGN
Connector hinge for oil containment booms, 3:25805
OIL SAND DEPOSITS
See also ATHABASCA DEPOSIT
COLD LAKE DEPOSIT
OIL SAND DEPOSITS/IN-SITU COMBUSTION
Role for nuclear energy in the recovery of oil from the tar sands of Alberta, 3:25894
OIL SAND DEPOSITS/STEAM INJECTION
Role for nuclear energy in the recovery of oil from the tar sands of Alberta, 3:25894

OIL SAND DEPOSITS/SURFACE MINING
Role for nuclear energy in the recovery of oil from the tar sands of Alberta, 3:25894
OIL SAND PROCESSING PLANTS/PILOT PLANTS
Heavy oil sand in-situ pilot plants in Alberta (past and present), 3:25895
OIL SANDS/IN-SITU COMBUSTION
In situ recovery process for the oil sands of Alberta, 3:25898
OIL SANDS/IN-SITU PROCESSING
Electrical induction heating: a new concept in in situ recovery, 3:25616
Heavy oil sand in-situ pilot plants in Alberta (past and present), 3:25895
In situ recovery process for the oil sands of Alberta, 3:25898
Oil sands in situ projects continue at impressive rate, 3:25897
OIL SHALE DEPOSITS/DEGASSING
Methane absorption in oil shale and its potential mine hazard. Report of investigations 1977, 3:25893 (PB-271219)
OIL SHALE INDUSTRY/AIR POLLUTION ABATEMENT
Advanced fossil fuel and the environment: an executive report, 3:26192 (EPA-600/9-77-013)
OIL SHALE MINING
See also SURFACE MINING
UNDERGROUND MINING
OIL SHALE MINING/ENVIRONMENTAL EFFECTS
Oil shale and the environment, 3:25902 (EPA-600/9-77-033)
OIL SHALE MINING/HAZARDS
Methane absorption in oil shale and its potential mine hazard. Report of investigations 1977, 3:25893 (PB-271219)
OIL SHALES/COMBUSTION PRODUCTS
Problems of energy utilization of bituminous shale, 3:25901
OIL SHALES/COMBUSTION PROPERTIES
Problems of energy utilization of bituminous shale, 3:25901
OIL SHALES/EXPLOITATION
Oil shale and the environment, 3:25902 (EPA-600/9-77-033)
OIL SPILLS/BIBLIOGRAPHIES
Oil spill removal techniques and equipment (a bibliography with abstracts). Report for 1965-September 1977, 3:25803 (NTIS/PS-77/0750)
Oil water separators (a bibliography with abstracts). Report for 1964-Nov 77, 3:25804 (NTIS/PS-77/1004)
OIL SPILLS/BIODEGRADATION
Biodegradation of oil in seawater for naval pollution control. Final report 1974-1976, 3:25798 (AD-A-042375)
OIL SPILLS/CLEANING
Connector hinge for oil containment booms, 3:25805
Contingency planning for the impact of oil spills in different coastal environments of Canada. Technical report, 3:26905 (AD-A-043713)
Oil water separators (a bibliography with abstracts). Report for 1964-Nov 77, 3:25804 (NTIS/PS-77/1004)
OPC-3000 coalescing plate oil/water separator evaluation. Technical memo, 3:25799 (AD-A-046123)
OIL SPILLS/EMERGENCY PLAN
Contingency planning for the impact of oil spills in different coastal environments of Canada. Technical report, 3:26905 (AD-A-043713)
OIL SPILLS/ENVIRONMENTAL TRANSPORT
Development of additional hazard assessment models. Final technical report, 3:26929 (AD-A-042365)
OIL SPILLS/ORIGIN
Methods of identifying source of petroleum found in the marine environment. Report II. Final report 26 Jun 72-17 May 76, 3:25800 (AD-A-046256)
OIL WELLS
See also PETROLEUM
OIL WELLS/MICROEMULSION FLOODING
Pressure drop and flow distribution of a polymer solution in a non-homogeneous porous medium, 3:25752
OIL WELLS/MISCIBLE-PHASE DISPLACEMENT
Experimental investigation of the displacement of uniform mixing nonnewtonian systems, 3:25758
OIL WELLS/PUMPS
Determination of leakage of a liquid obeying an exponential model, in the piston-cylinder gap of a deep pump, 3:25759
OIL WELLS/STEAM INJECTION
M6 steam drive project design and implementation, 3:25751
OIL WELLS/TEMPERATURE MEASUREMENT
Geologo-technical efficiency of rising thermometry and radioisotopes in investigation of pumping wells in Tataria, 3:25763
OIL WELLS/WATERFLOODING
Review of petroleum oil saturation and its determination, 3:25746 (BERC/RI-77/15)
Salinity tolerant surfactant oil recovery process (Patent), 3:25747
OIL WELLS/WELL CASINGS
Geologo-technical efficiency of rising thermometry and radioisotopes in investigation of pumping wells in Tataria, 3:25763
OKLO PHENOMENON
Analysis of possibility of reactors occurring in nature, 3:26350
Uranium solubilities in the Oklo reactor zones, 3:27016 (LA-UR-77-2818)
OLEFINS
See ALKENES
OMEGA-784 RESONANCES/INTERFERENCE
etaeta' and ωphi mixing in the nonrelativistic quark model, 3:27179
ON-LINE SYSTEMS/SAFETY
Safety considerations for application of process stream analyzers in petrochemical plants, 3:25794
ONTARIO PHWR PICKERING-1 REACTOR
See PICKERING-1 REACTOR
ONTARIO PHWR PICKERING-2 REACTOR
See PICKERING-2 REACTOR
ONTARIO PHWR PICKERING-3 REACTOR
See PICKERING-3 REACTOR
ONTARIO PHWR PICKERING-4 REACTOR
See PICKERING-4 REACTOR
OPE MODEL/NUCLEON-NUCLEON INTERACTIONS
Dynamics of N-N total cross sections at medium energies, 3:27227
OPEN PLASMA DEVICES/DRIFT INSTABILITY
Anomalous transport effects in magnetically-confined plasma columns, 3:27439
OPERATORS (MATHEMATICAL)
See MATHEMATICAL OPERATORS
OPERATORS(QUANTUM MECHANICAL)
See QUANTUM OPERATORS
OPTICAL EQUIPMENT/DESIGN
Micro-Fresnel zone plates for coded imaging applications, 3:27473
OPTICAL MODELS/COULOMB EXCITATION
Long-range absorption in the heavy-ion optical potential, 3:27369
OPTICAL MODELS/HEAVY ION REACTIONS
Energy dependence in heavy-ion optical-potential elastic scattering, 3:27393
OPTICAL MODELS/NUCLEAR POTENTIAL
Anomalous optical-model potential for sub-Coulomb protons for $89 < A < 130$, 3:27361
Long-range absorption in the heavy-ion optical potential, 3:27369
OPTICAL MODELS/THREE-BODY PROBLEM
Three-body approach to the single-scattering optical potential, 3:27394
OPTICAL MODELS/TOTAL CROSS SECTIONS
Anomalous optical-model potential for sub-Coulomb protons for $89 < A < 130$, 3:27361
OPTICAL SYSTEMS/PHYSICAL RADIATION EFFECTS
Effects of fast and thermal neutron flux and gamma radiation on the transmission characteristics of optical fibers. Interim report, 3:26659 (AD-A-042429)
OPTICAL SYSTEMS/RADIATION HARDENING
State of the art in fiber optics communications and data transfer. Interim report, 3:26660 (AD-A-042579)
ORBITAL SOLAR POWER PLANTS/ENVIRONMENTAL IMPACTS
Development of a satellite solar power station, 3:26031
ORBITAL SOLAR POWER PLANTS/SOCIO-ECONOMIC FACTORS
Development of a satellite solar power station, 3:26031
ORBITAL SOLAR POWER PLANTS/TECHNOLOGY ASSESSMENT
Development of a satellite solar power station, 3:26031
ORC FLASH PYROLYSIS PROCESS
See OCCIDENTAL FLASH PYROLYSIS PROCESS
ORDNANCE
Event dice throw, mobility experiments. Final report (Cratering explosions as barrier to movement of military vehicles), 3:26858 (AD-A-046146)
OREGON/ENERGY SOURCE DEVELOPMENT
Western States energy resource development update 1976, 3:26503
OREGON/ENERGY SUPPLIES
Northwest Energy Policy Project. Energy supply and environmental impacts: conventional energy sources. Study Module III-A final report, 3:26512 (NP-23054)
ORGANIC COMPOUNDS
See also CHEMICAL FEEDSTOCKS
HYDROCARBONS
KETONES
ORGANIC NITROGEN COMPOUNDS
ORGANIC POLYMERS
ORGANIC SULFUR COMPOUNDS
ORGANOMETALLIC COMPOUNDS
PROTEINS
ORGANIC COMPOUNDS/CHEMICAL ANALYSIS
Application of a GC/MS data system at Rocky Flats, 3:26839 (RFP-2558)
Environmental assessment of the HYGAS Process. Project No. 9025 monthly progress report, August 1-August 31, 1977, 3:25637 (FE-2433-18)

ORGANIC NITROGEN COMPOUNDS
See also AMIDES
AMINO ACIDS
ASPARAGINE
BUDR
CHLOROPHYLL
OXADIAZOLES
PORPHYRINS
PROTEINS
TRYPTOPHAN
ORGANIC NITROGEN COMPOUNDS/BIODEGRADATION
Heat treatment of organics for increasing anaerobic biodegradability. Quarterly progress report, March 1, 1977-May 31, 1977, 3:26007 (COO/2991-19)
ORGANIC POLYMERS
See also RESINS
RUBBERS
ORGANIC POLYMERS/CHEMICAL RADIATION EFFECTS
Radiation degradation susceptibility of several related polymers. Research and development technical report, 3:26693 (AD-A-042525)
ORGANIC POLYMERS/PERMEABILITY
Transport of liquids and gases through coatings, 3:26689
ORGANIC SOLVENTS
Catalyst development for coal liquefaction. Annual report, July 1, 1976-June 30, 1977 (Panasol AN3), 3:25657 (FE-2335-13)
ORGANIC SOLVENTS/HYDROGENATION
EDS coal liquefaction process development, Phase III B. Monthly technical progress report, December 1-December 31, 1977, 3:25660 (FE-2893-6)
ORGANIC SULFUR COMPOUNDS
See also THIOCYANATES
THIOPHENE
ORGANIC SULFUR COMPOUNDS/ELECTRON MICROPROBE ANALYSIS
New method for sulphur concentration measurements in coal and char, 3:25670
ORGANIC WASTES/ANAEROBIC DIGESTION
Technology for the conversion of solar energy to fuel gas. Annual report, 3:25964 (PB-271142)
ORGANOIDS
See also ENDOPLASMIC RETICULUM
MITOCHONDRIA
ORGANOIDS/SECRETION
Decidual cell secretion, a unique mode of exocytosis, 3:26955 (CONF-770504-)
ORGANOMETALLIC COMPOUNDS/BOND LENGTHS
Determination of local structures of platinum uridine blues and purples by extended x-ray absorption fine structure spectroscopy, 3:26675
ORGDP
(Oak Ridge Gaseous Diffusion Plant.)
ORGDP/IONIZATION CHAMBERS
Performance tests of the ORGDP radiation detection instruments (Compliance with Criticality Accident Alarm Systems), 3:26821 (Y/DD-215)
ORMAK DEVICES/REACTOR FUELING
Solid hydrogen pellet injection into the ORMAK tokamak, 3:27664
ORNL ISOCHRONOUS CYCLOTRON/NEUTRON SOURCES
Characteristics of an intense neutron source based on the d+Be reaction, 3:26794
ORNL RESEARCH REACTOR
See ORR REACTOR
ORR REACTOR/REACTOR OPERATION
Oak Ridge Research Reactor quarterly report, April, May, and June of 1977, 3:26423 (ORNL/TM-6200)
ORR REACTOR/SPECIFICATIONS
Technical specifications for the Oak Ridge Research Reactor, 3:26422 (ORNL/TM-5999)
OSMIUM/ION EXCHANGE
Cation exchange of 53 elements in nitric acid, 3:26665 (LA-7083)
OXADIAZOLES/QUANTITATIVE CHEMICAL ANALYSIS
Laser two-proton excited fluorometric detection for high pressure liquid chromatography, 3:26837 (IS-T-792)
OXYGEN/CHEMICAL ANALYSIS
Environmental assessment of the HYGAS Process. Project No. 9025 monthly progress report, August 1-August 31, 1977, 3:25637 (FE-2433-18)
OXYGEN/CHEMICAL REACTION KINETICS
Rate parameters for the reactions of formaldehyde with H-atoms and O-atoms over the temperature range 250 to 470 K, 3:26670 (BNL-23550)
OXYGEN/DENSITY
Roscoe manual. Volume 14B. Midlatitude density profiles of selected atmospheric species. Final report, 2 March 1974-28 February 1975, 3:26852 (AD-A-043499)
OXYGEN/ION-MOLECULE COLLISIONS
K-shell capture by protons from O_2, N_2, and Ne, 3:27070
OXYGEN/REMOVAL
Trapping and removal of oxygen in tokamaks, 3:27628
OXYGEN 14/BETA-PLUS DECAY
Beta decays and related processes in the A = 14 nuclei, 3:27326
OXYGEN 16/HYPERNUCLEI
Possibility of charmed hypernuclei, 3:27228
OXYGEN 16 REACTIONS/COMPOUND-NUCLEUS REACTIONS
High-spin states in ^{64}Zn, 3:27357
OXYGEN 16 REACTIONS/ELASTIC SCATTERING
Low energy elastic scattering from ^{28}Si targets using projectiles with 9 < or = A < or = 18, 3:27344
Surface transparent potentials: forward angle transfer and backward angle elastic scattering in heavy-ion collisions (Cross sections, tau, π), 3:27338 (BNL-23461)
OXYGEN 16 REACTIONS/FUSION REACTIONS
Fusion of ^{16}O + ^{40}Ca (45 to 63 MeV: cross sections), 3:27350 (ANL-77-60)
Systematics of O + Mg fusion (18 to 50 MeV (c.m.): excitation function), 3:27340 (ANL-77-60)
OXYGEN 16 REACTIONS/INELASTIC SCATTERING
Folding model description of heavy ion inelastic scattering, 3:27328
Inelastic scattering of ^{16}O on even-Ca isotopes (56, 60 MeV: angular distributions), 3:27352 (ANL-77-60)
Surface transparent potentials: forward angle transfer and backward angle elastic scattering in heavy-ion collisions (Cross sections, tau, π), 3:27338 (BNL-23461)
OXYGEN 16 REACTIONS/ONE-NUCLEON TRANSFER REACTIONS
Energy dependence of the distribution of reaction strength in the ^{16}O + ^{40}Ca collisions (75 MeV), 3:27351 (ANL-77-60)
OXYGEN 16 TARGET/PION PLUS REACTIONS
Properties of inclusive (π^+,π^0) reactions in nuclei, 3:27334
OXYGEN 17 TARGET/PHOTONUCLEAR REACTIONS
Direct and resonance photoneutron reactions of ^{17}O (4.5 to 7.1 MeV: cross sections), 3:27331 (ANL-77-60)
OXYGEN 18/CHARGE DISTRIBUTION
Neutron deformation parameter from comparative study of π^+ and π^- inelastic scattering, 3:27335
OXYGEN 18/ENERGY LEVELS
Surface transparent potentials: forward angle transfer and backward angle elastic scattering in heavy-ion collisions (Cross sections, tau, π), 3:27338 (BNL-23461)
OXYGEN 18 REACTIONS/ELASTIC SCATTERING
Long-range absorption in the heavy-ion optical potential, 3:27369
Low energy elastic scattering from ^{28}Si targets using projectiles with 9 < or = A < or = 18, 3:27344
OXYGEN 18 REACTIONS/FISSION
Measurement of the effective widths of excited states of heavy nuclei (Z=98, 100, 102) by means of the blocking effect, 3:27382
OXYGEN 18 TARGET/OXYGEN 16 REACTIONS
Surface transparent potentials: forward angle transfer and backward angle elastic scattering in heavy-ion collisions (Cross sections, tau, π), 3:27338 (BNL-23461)
OXYGEN 18 TARGET/PION MINUS REACTIONS
Neutron deformation parameter from comparative study of π^+ and π^- inelastic scattering, 3:27335
OXYGEN 18 TARGET/PION PLUS REACTIONS
Neutron deformation parameter from comparative study of π^+ and π^- inelastic scattering, 3:27335
OXYGEN EFFECT (RADIOBIOLOGY)
See OXYGEN
OXYMETHYLENE
See FORMALDEHYDE
OZONE/AIR POLLUTION CONTROL
Cost/effectiveness analysis of the Illinois ozone episode regulation (R75-4). Final Report, 3:26890 (PB-270896)
OZONE/DENSITY
Roscoe manual. Volume 14B. Midlatitude density profiles of selected atmospheric species. Final report, 2 March 1974-28 February 1975, 3:26852 (AD-A-043499)

P

P INVARIANCE/SYMMETRY BREAKING
Tests of spontaneous left-right-symmetry breaking, 3:27252
PAIR PRODUCTION/BETHE-HEITLER THEORY
Neutral-current effects in Bethe-Heitler pair production, 3:27175
PAIR PRODUCTION/WEAK NEUTRAL CURRENTS
Neutral-current effects in Bethe-Heitler pair production, 3:27175
PAKS-1 REACTOR/LOSS OF COOLANT
Breakdown transient phenomena at the fall-out of the primary circuit cooling pumps at Paks Nuclear Power Plant, 3:26474

PALLADIUM/ION EXCHANGE
Cation exchange of 53 elements in nitric acid, 3:26665 (LA-7083)
PALLADIUM 105 TARGET/PROTON REACTIONS
Anomalous optical-model potential for sub-Coulomb protons for $89 < A < 130$, 3:27361
PALLADIUM 110 TARGET/PROTON REACTIONS
Anomalous optical-model potential for sub-Coulomb protons for $89 < A < 130$, 3:27361
PANCREAS/RADIOISOTOPE SCANNING
Biomedical research and application utilizing cyclotron produced radionuclides. Progress report, January 1 1977-December 31, 1977, 3:26971 (COO/4268-1)
PARABOLIC REFLECTORS
See also COMPOUND PARABOLIC CONCENTRATORS
PARABOLIC REFLECTORS/**DESIGN**
Solar cell equipment with concentrating mirrors and radiator surfaces, 3:25997
PARAFFINS
See ALKANES
PARAMETRIC INSTABILITIES
Induced radiation from a plasma cylinder, 3:27577
PARITY NONCONSERVATION
See P INVARIANCE
PARTICLE INTERACTIONS/EIKONAL APPROXIMATION
Relativistic eikonal expansion, 3:27153
PARTICLE INTERACTIONS/QUANTUM FIELD THEORY
Collective phenomena and renormalization of nonlinear spinor theories (Nambu-Jona-Lasino model, perturbation series), 3:27288
PARTICLE INTERACTIONS/TRANSVERSE MOMENTUM
Constituent models and large transverse momentum reactions (Lectures), 3:27107 (SLAC-PUB-1733)
PARTICLE MODELS
See also COLOR MODEL
COMPOSITE MODELS
GLUON MODEL
HIGGS MODEL
ISOBAR MODEL
JET MODEL
PERIPHERAL MODELS
QUARK MODEL
STRING MODELS
UNIFIED GAUGE MODELS
PARTICLE MODELS/**TRANSVERSE MOMENTUM**
Constituent models and large transverse momentum reactions (Lectures), 3:27107 (SLAC-PUB-1733)
PARTICLE PRODUCTION/SYMMETRY BREAKING
Dynamical symmetry breakdown, 3:27248
PARTICLE RESUSPENSION/MATHEMATICAL MODELS
Wind effected redistribution of surface contamination. Final report, September 1972-August 1976, 3:26880 (ORO-4394-4)
PARTICLE SIZE CLASSIFIERS/DESIGN
Method for rapid particle size analysis by hydrosizing and nuclear sensing (Patent), 3:26832
PARTICLES (FUEL)
See FUEL PARTICLES
PARTON MODEL/LEPTON-PROTON INTERACTIONS
Relativistic interactions in nuclei and the approach to scaling in deep inelastic scattering, 3:27390 (SLAC-203)
PARTON MODEL/MULTIPLE PRODUCTION
Parton-picture unitary impact-parameter model for multicluster production, 3:27229
PARTON MODEL/MUON-PROTON INTERACTIONS
Clean tests of quantum chromodynamics in μp scattering, 3:27172
PARTON MODEL/SCALE INVARIANCE
Distinguishing scaling violations from new currents, 3:27194
PATIENTS/DIAGNOSTIC TECHNIQUES
Biomedical research and application utilizing cyclotron produced radionuclides. Progress report, January 1 1977-December 31, 1977, 3:26971 (COO/4268-1)
PATIENTS/RADIOISOTOPE SCANNING
Tumor scanning agents, 3:26973
PCM ACCIDENTS
See POWER-COOLING-MISMATCH ACCIDENTS
PEARL SPAR
See DOLOMITE
PEAS/PHOTOSYNTHESIS
Effect of light on respiration and development of photosynthetic cells. Progress report, June 1, 1976-August 31, 1977 (Chlamydomonas, Euglena, spinach, peas), 3:26969 (COO-3231-5)
PEBBLE BED REACTORS/HEAT PIPES
Reactor and advanced heat transfer technology, 3:26705 (LA-6807-PR)
PEBBLE BED REACTORS/REACTOR CORES
Hot spots in active packed beds, 3:26257
Pebble bed reactor with one-zone core (Patent), 3:26262
PEBBLE BED REACTORS/REACTOR FUELING
Pebble bed reactor with one-zone core (Patent), 3:26262
Refuelling system for a nuclear reactor with a reactor core showing (presenting) a pebble bed of spherical fuel elements, 3:26261
PELLETS (FUEL)
See FUEL PELLETS
PENNING ION SOURCES
Alternate approaches to D- beam production, 3:27659 (UCID-17672)
PENNING ION SOURCES/COOLING SYSTEMS
Cathode cooling systems for the magnetron and Penning H^- sources: a progress report of work at Brookhaven National Laboratory, 3:26801 (BNL-23654)
PENTADIENES/CHEMICAL PROPERTIES
Synthetic methods of using secondary pyrolysis by-products (Piperylene (1,3-pentadiene); methylacetylene), 3:25792
PENTANE/ISOMERIZATION
Isomerization of n-pentane on group VIII metal/hydrogen-zeolite Y catalysts, 3:25783
PEP STORAGE RINGS
(Positron-electron-proton storage ring.)
PEP STORAGE RINGS/**BEAM PULSERS**
Fast pulse beam generation systems for electron accelerators, 3:26797 (SLAC-PUB-1948)
PEP STORAGE RINGS/**DESIGN**
Present and future colliding beam facilities at SLAC, 3:26813 (SLAC-PUB-1971)
PEP STORAGE RINGS/**ELECTROMAGNETS**
PEP main ring magnet system, 3:26814 (SLAC-PUB-2045)
PEP STORAGE RINGS/**RF SYSTEMS**
RF system for the PFP storage ring, 3:26812 (SLAC-PUB-1898)
PEP STORAGE RINGS/**USES**
Possibility of coherent hard x-ray production by pumping with synchrotron radiation and low energy photons. Period covered: November 17, 1976-August 16, 1977, 3:26741 (RLO/2230/T5-192)
PEP STORAGE RINGS/**VACUUM SYSTEMS**
Glow discharge processing vs bakeout for aluminum storage ring vacuum chambers, 3:26815 (SLAC-PUB-2053)
PERIPHERAL MODELS/PSI RESONANCES
Photoproduction of J/psi mesons in the peripheral model. The direct peripheral mechanism, 3:27181
PERKINS-1 REACTOR
Standardization facilitated by Duke's in-house capability for design and construction, 3:26235
World's reactor, No. 72. Cherokee/Perkins Nuclear Stations, 3:26232
PERKINS-1 REACTOR/**CONTAINMENT**
Spherical containment system has many advantages, 3:26447
PERKINS-1 REACTOR/**SITE SELECTION**
Selecting sites for ease of licensing requirements, 3:26414
PERKINS-2 REACTOR
Standardization facilitated by Duke's in-house capability for design and construction, 3:26235
World's reactor, No. 72. Cherokee/Perkins Nuclear Stations, 3:26232
PERKINS-2 REACTOR/**SITE SELECTION**
Selecting sites for ease of licensing requirements, 3:26414
PERKINS-3 REACTOR
Standardization facilitated by Duke's in-house capability for design and construction, 3:26235
World's reactor, No. 72. Cherokee/Perkins Nuclear Stations, 3:26232
PERKINS-3 REACTOR/**SITE SELECTION**
Selecting sites for ease of licensing requirements, 3:26414
PERSONNEL
See also MINERS
PERSONNEL/**RADIATION DOSES**
Occupational doses in the Ontario Hydro nuclear power program, 3:26463
PERSONNEL MONITORING/AUTOMATION
Personnel monitoring by process computers in nuclear power stations, 3:26461
PERTURBATION THEORY
Singular perturbation method for evolution equations in Banach spaces, 3:27422
PERTURBATION THEORY/**DIMENSIONS**
Violations of dimensional analysis in renormalized perturbation theory, 3:27282
PETROCHEMICAL PLANTS/CHEMICAL FEEDSTOCKS
Pyrolysis of petroleum fractions as the main source of raw material for the petrochemical industry, 3:25791
PETROCHEMICAL PLANTS/**ON-LINE SYSTEMS**
Safety considerations for application of process stream analyzers in petrochemical plants, 3:25794
PETROCHEMICAL PLANTS/**OPERATION**
Adances in petrochemical technology, 3:25765
PETROCHEMICAL PLANTS/**POLLUTION CONTROL**
Waste processing and pollution in the chemical and petrochemical industries. Volume 2. 1975-August 1977 1977 (a bibliography

with abstracts). Report for 1975-August 1977, 3:25797 (NTIS/PS-77/0706)
PETROCHEMICAL PLANTS/TECHNOLOGY ASSESSMENT
Some recent trends and advances in petrochemical technology, 3:25766
PETROCHEMICALS
See also CHEMICAL FEEDSTOCKS
PETROCHEMICALS/ANAEROBIC DIGESTION
Effect of molecular structure on methane fermentability, 3:26006 (COO/2991-19)
PETROCHEMICALS/PRODUCTION
Main developmental tendencies in the high-volume, organic synthesis industry, 3:25790
Pyrolysis of petroleum fractions as the main source of raw material for the petrochemical industry, 3:25791
PETROCHEMICALS/WASTE PROCESSING
Effect of molecular structure on methane fermentability, 3:26006 (COO/2991-19)
PETROLEUM
See also OIL WELLS
WELL STIMULATION
PETROLEUM/BIODEGRADATION
Biodegradation of oil in seawater for naval pollution control. Final report 1974-1976, 3:25798 (AD-A-042375)
PETROLEUM/CATALYTIC CRACKING
Commercialization of new technology for two-stage cascade-countercurrent catalytic cracking, 3:25778
Effect of catalytic cracking method in product yields, 3:25774
Some recent trends and advances in petrochemical technology, 3:25766
PETROLEUM/CHEMICAL COMPOSITION
Character of distribution of naphthene acids in petroleums of lower Kura depression deposits, 3:25817
Crude oils from new commercial fields in Belorussia, 3:25815
Crude oils of the Georgian SSR, 3:25819
PETROLEUM/CHEMICAL PROPERTIES
Crude oils from new commercial fields in Belorussia, 3:25815
Crude oils of the Georgian SSR, 3:25819
PETROLEUM/DESALINATION
Efficiency of crude oil desalting in horizontal electrodehydrators, 3:25777
PETROLEUM/EMULSIFICATION
Electrolyte and pH effect on emulsion stability of water-in-petroleum oils, 3:25813
PETROLEUM/ENHANCED RECOVERY
Salinity tolerant surfactant oil recovery process (Patent), 3:25747
PETROLEUM/ENVIRONMENTAL EFFECTS
Aquatic ecology, 3:26924 (TID-26712)
PETROLEUM/HYDRAULIC TRANSPORT
Efficiency of hydraulic shipment of highly viscous oils in channels of rectangular cross section, 3:25810
PETROLEUM/HYDROCRACKING
Some recent trends and advances in petrochemical technology, 3:25766
PETROLEUM/MARITIME TRANSPORT
Noise of cargo oil pumps and effect on accommodation of large tanker, 3:25809
PETROLEUM/MARKET
NEB veiw of development potential and markets for heavy crude oil, 3:25814
PETROLEUM/PHYSICAL PROPERTIES
Crude oils from new commercial fields in Belorussia, 3:25815
Crude oils of the Georgian SSR, 3:25819
NEB veiw of development potential and markets for heavy crude oil, 3:25814
PETROLEUM/PRODUCTION
Geology and petroleum of the Mancos B formation, Douglas Creek arch area, Colorado and Utah, 3:25738
PETROLEUM/REFINING
Crude oils from new commercial fields in Belorussia, 3:25815
Crude oils of the Georgian SSR, 3:25819
Influence of alcohols on urea-adduct formation with solid paraffins, 3:25779
PETROLEUM/TRANSPORT
Alaskan oil transportation issues, 3:25801 (EPA-600/9-77-019)
PETROLEUM/UNDERGROUND STORAGE
Use of gamma-gamma logging in the operation of underground reservoirs for gas and petroleum products in rock salt deposits, 3:25823 (UCRL-Trans-11314)
PETROLEUM DEPOSITS
See also GAS CONDENSATE FIELDS
OIL FIELDS
Effect of thermal field on oil-gas formation in mesozoic deposits of the Western Siberian plate, 3:25728
Petroleum potential of southwestern Wyoming and adjacent areas, 3:25737
Shallow marine deposits in the Upper Cretaceous Pierre Shale of the northern Denver basin and their relation to hydrocarbon accumulation, 3:25739
PETROLEUM DEPOSITS/EXPLORATION
Biostratigraphic correlation of the Mesaverde Group in southwestern Wyoming and northwestern Colorado, 3:25736
Fractured shale hydrocarbon reservoirs in southern Rocky Mountain basins, 3:25734
Interpretation of seismic reflection data from the central South Park basin, Colorado, 3:25732
Oil potential of Mesozoic sediments beneath the Independence Mountain thrust fault, North Park, Colorado, 3:25731
Preliminary report: petroleum geochemistry of the Denver basin, 3:25741
Seismic investigation of the Colorado Front Range Zone of flank deformation immediately north of Golden, Colorado, 3:25733
Seismic stratigraphic exploration: a new frontier, 3:25735
Structural style in relation to oil and gas exploration in North Park-Middle Park basin, Colorado, 3:25730
PETROLEUM DEPOSITS/GEOCHEMISTRY
Preliminary report: petroleum geochemistry of the Denver basin, 3:25741
PETROLEUM DEPOSITS/GEOLOGY
Geology of the Amoco Imp Skelly A-1 Osprey H-84 well, Grand Banks, Newfoundland, 3:25743
Regularities in the arrangement and formation conditions of zones of oil and gas accumulation in jurassic deposits of south Russia, 3:25744
PETROLEUM DEPOSITS/GRAVITY SURVEYS
Experience of application of multidimensional regression analysis in connection with integrated interpretation of local gravitational anomalies of structurally complex regions of Azerbaiian, 3:25742
PETROLEUM DEPOSITS/NEUTRON-GAMMA LOGGING
Estimation of carbonate reservoirs of East Turkmeniya from the lateral-logging and neutron-gamma logging data, 3:25829
PETROLEUM DEPOSITS/PERMEABILITY
Numerical method of determination of hydrodynamic conductibility of a nonhomogeneous oil-bearing stratum, 3:25750
PETROLEUM DEPOSITS/PROSPECTING
Relations between the depth and surface tectonics of the Urals and Priurals and their significance in searching for oil and gas, 3:25727
PETROLEUM DEPOSITS/RESISTIVITY LOGGING
Estimation of carbonate reservoirs of East Turkmeniya from the lateral-logging and neutron-gamma logging data, 3:25829
PETROLEUM DEPOSITS/TECTONICS
Recognition of fossil karst features in the ancient record: a discussion of several common fossil karst forms, 3:25740
PETROLEUM DISTILLATES/CHEMICAL PROPERTIES
Oil and gas condensate from Luginets field, 3:25795
PETROLEUM DISTILLATES/HYDROGENATION
Influence of feedstock distillation range on hydrocarbon conversion and changes in luminometer number upon dearomatization of distillates from Nizhnevartovsk crude oil, 3:25771
PETROLEUM DISTILLATES/PHYSICAL PROPERTIES
Oil and gas condensate from Luginets field, 3:25795
PETROLEUM FRACTIONS/PYROLYSIS
Pyrolysis of petroleum fractions as the main source of raw material for the petrochemical industry, 3:25791
PETROLEUM INDUSTRY/HORIZONTAL DIVESTITURE
Divestiture: the pros and cons, 3:26520
PETROLEUM INDUSTRY/VERTICAL DIVESTITURE
Divestiture: the pros and cons, 3:26520
PETROLEUM PRODUCTS
See also GASOLINE
LUBRICATING OILS
REFINERY GASES
PETROLEUM PRODUCTS/HYDROCRACKING
Optimal conditions for selective hydrocracking of raffinates, 3:25773
PETROLEUM REFINERIES/CHEMICAL REACTORS
Limits of existence of fluidized bed of solid particles in vessel with dual-flow grid, 3:25780
PETROLEUM REFINERIES/ON-LINE SYSTEMS
Safety considerations for application of process stream analyzers in petrochemical plants, 3:25794
PETROLEUM REFINERIES/OPERATION
Adances in petrochemical technology, 3:25765
PETROLEUM RESIDUES/COKING
Chemical composition of naphthas from coking of petroleum residues, 3:25820
PETROLEUM RESIDUES/OXIDATION
Influence of air input rate on oxidation of residuum in the presence of ferric chloride, 3:25789
PETROLEUM RESIDUES/PROCESSING
Increasing the efficiency of production of high. VI. Residual lube oils from Mangyshlak crude, 3:25788

PETULA TOKAMAK/ENERGY BALANCE
Plasma energy balance in PETULA experiment, 3:27500 (CEA-CONF-3859)
PETULA TOKAMAK/IMPURITIES
Alumina-plasma interaction in the PETULA Tokamak, 3:27608 (CEA-CONF-3860)
PETULA TOKAMAK/VACUUM SYSTEMS
Alumina-plasma interaction in the PETULA Tokamak, 3:27608 (CEA-CONF-3860)
PHAGES
See BACTERIOPHAGES
PHENOL/CHEMICAL REACTIONS
Homogeneous catalytic hydrocracking processes for conversion of coal to liquid fuels: basic and exploratory research. Quarterly report No. 7, May 1, 1977-July 31, 1977, 3:25653 (FE-2202-21)
PHENOL/OXIDATION
Complete catalytic oxidation of vapor mixtures containing phenol and hydrogen sulfide, 3:26678
PHI-1019 RESONANCES/INTERFERENCE
etaeta′ and ωphi mixing in the nonrelativistic quark model, 3:27179
PHILIPPSBURG-1 REACTOR/PERSONNEL DOSIMETRY
Use of an evaluation device for rod dosimeters in the process computer-aided personnel dosimetry monitoring at the Philippsburg nuclear power station, 3:26460
PHILIPPSBURG-2 REACTOR/PERSONNEL DOSIMETRY
Use of an evaluation device for rod dosimeters in the process computer-aided personnel dosimetry monitoring at the Philippsburg nuclear power station, 3:26460
PHOSPHATIDES
See PHOSPHOLIPIDS
PHOSPHIDES/KNIGHT SHIFT
Systematics in the Knight shift of rare-earth monopnictides, 3:26600
PHOSPHOLIPIDS/BIOSYNTHESIS
Membrane biogenesis: an application of biochemistry and cytochemistry to electron microscopy, 3:26953 (CONF-770504-)
PHOSPHORUS COMPOUNDS/CATALYTIC EFFECTS
Distinctive catalysis by phosphonium and sulfonium compounds in low-temperature liquid-phase hydrocarbon oxidation, 3:26688
PHOTOCHEMISTRY
Annual progress report, September 1, 1976-November 30, 1977 (Chromophores in photosynthetic membranes and reaction centers of Rhodopseudomonas sp.), 3:26945 (COO-3162-36)
PHOTODETECTORS/LIGHT SCATTERING
Single-particle light-scattering measurements with a photodiode array, 3:26823
PHOTODISINTEGRATION
See PHOTONUCLEAR REACTIONS
PHOTOELECTRON SPECTROSCOPY/RESEARCH PROGRAMS
Technical progress report, 1 July 1976-30 November 1977 (Summaries of research activities at California Institute of Technology), 3:27064 (CALT-767P4-161)
PHOTOMETRY/COMPARATIVE EVALUATIONS
Applications of interference microscopy for measurements on the cell nucleus in comparison with impulse cytophotometry, 3:26966 (LA-tr-78-4)
PHOTON TRANSPORT
(For diffusion or transmission of energetic photons in material media.)
PHOTON TRANSPORT/ENERGY LOSSES
Energy deposition rates and Compton electron currents from low-altitude bursts as a function of source energy. Interim report 17 Nov 76-1 Nov 77, 3:27042 (AD-A-046092)
PHOTON-MOLECULE COLLISIONS/ABSORPTION
Photoabsorption in molecular nitrogen: A moment analysis of discrete-basis-set calculations in the static-exchange approximation, 3:27084
PHOTON-MOLECULE COLLISIONS/PHOTOIONIZATION
Photoabsorption in molecular nitrogen: A moment analysis of discrete-basis-set calculations in the static-exchange approximation, 3:27084
PHOTON-PHOTON INTERACTIONS/KINETICS
Implications of a nonzero neutrino mass for the process $\gamma\gamma \rightarrow \nu\nu$-bar, 3:27200
PHOTON-PHOTON INTERACTIONS/VACUUM POLARIZATION
Contribution to the eighth-order anomalous magnetic moment of the muon, 3:27173
PHOTON-PROTON INTERACTIONS/PHOTOPRODUCTION
Asymmetry of the cross section of the photoproduction of eta mesons by polarized photons in the resonant energy region, 3:27105
PHOTONS/MASS FORMULAE
Radiative decays of fermions and the mass of the photon, 3:27178
PHOTONUCLEAR REACTIONS
Distribution of M1 strength in ^{208}Pb (7.5 to 10 MeV excitation, polarization and analyzing power), 3:27376 (ANL-77-60)
psi and excess leptons in photoproduction (A dependence, cross sections, preliminary report), 3:27099 (SLAC-PUB-1728)
PHOTONUCLEAR REACTIONS/**DIRECT REACTIONS**
Direct and resonance photoneutron reactions of ^{17}O (4.5 to 7.1 MeV: cross sections), 3:27331 (ANL-77-60)
PHOTONUCLEAR REACTIONS/**PHOTOPRODUCTION**
Eikonal and quasi-eikonal models in the theory of complex angular momenta for pion elastic scattering and rho^0-meson photoproduction on ^{4}He nuclei, 3:27235
PHOTONUCLEAR REACTIONS/**PRECOMPOUND-NUCLEUS EMISSION**
Pre-equilibrium particle decay in the photonuclear reactions, 3:27327
PHOTOSPHERE/BALMER LINES
Comparison of H-alpha synoptic charts with the large-scale solar magnetic field as observed at Stanford. Scientific technical report, 3:27025 (AD-A-043336)
PHOTOSYNTHESIS
Effect of light on respiration and development of photosynthetic cells. Progress report, June 1, 1976-August 31, 1977 (Chlamydomonas, Euglena, spinach, peas), 3:26969 (COO-3231-5)
PHOTOSYNTHESIS/**REDOX REACTIONS**
Annual progress report, September 1, 1976-November 30, 1977 (Chromophores in photosynthetic membranes and reaction centers of Rhodopseudomonas sp.), 3:26945 (COO-3162-36)
PHOTOVOLTAIC POWER PLANTS
See also SOLAR CELL ARRAYS
PHOTOVOLTAIC POWER PLANTS/**COMPARATIVE EVALUATIONS**
Perspectives on utility central station photovoltaic applications, 3:26029 (EPRI-ER-589-SR)
PHOTOVOLTAIC POWER PLANTS/**COST**
Perspectives on utility central station photovoltaic applications, 3:26029 (EPRI-ER-589-SR)
PHOTOVOLTAIC POWER PLANTS/**ECONOMICS**
Solar Electric Energy Development: an energy policy alternative, 3:26030
PHOTOVOLTAIC POWER PLANTS/**ENVIRONMENTAL IMPACTS**
Solar Electric Energy Development: an energy policy alternative, 3:26030
PHOTOVOLTAIC POWER PLANTS/**FEASIBILITY STUDIES**
Solar Electric Energy Development: an energy policy alternative, 3:26030
PHWR TYPE REACTORS
See also BRUCE-1 REACTOR
BRUCE-2 REACTOR
BRUCE-3 REACTOR
BRUCE-4 REACTOR
PICKERING-1 REACTOR
PICKERING-2 REACTOR
PICKERING-3 REACTOR
PICKERING-4 REACTOR
PHWR TYPE REACTORS/**ELECTRICAL EQUIPMENT**
Electrical design aspects for nuclear power plants, 3:26272
PHYSICAL PROTECTION DEVICES/SYSTEMS ANALYSIS
Users guide for evaluating alternative fixed-site physical protection systems using "FESEM", 3:25954 (SAND-77-1367)
PHYSICS
See also HIGH ENERGY PHYSICS
NUCLEAR PHYSICS
Physics careers, employment and education (Penn State, 1977), 3:27425
PICEANCE CREEK BASIN/COAL RESERVES
Coal and methane gas in the southeastern part of the Piceance Creek basin, Colorado, 3:25688
PICEANCE CREEK BASIN/**NATURAL GAS DEPOSITS**
Possible future petroleum of Uinta and Piceance basins and vicinity: northeast Utah and northwest Colorado, 3:25726
PICEANCE CREEK BASIN/**NATURAL GAS WELLS**
Mesaverde hydraulic fracture stimulation, northern Piceance basin: progress report, 3:25860
PICEANCE CREEK BASIN/**PETROLEUM DEPOSITS**
Possible future petroleum of Uinta and Piceance basins and vicinity: northeast Utah and northwest Colorado, 3:25726
PICKERING-1 REACTOR/STEAM TURBINES
Wet steam turbines for nuclear generating stations -design and operating experience, 3:26273
PICKERING-2 REACTOR/STEAM TURBINES
Wet steam turbines for nuclear generating stations -design and operating experience, 3:26273
PICKERING-3 REACTOR/STEAM TURBINES
Wet steam turbines for nuclear generating stations -design and operating experience, 3:26273
PICKERING-4 REACTOR/STEAM TURBINES
Wet steam turbines for nuclear generating stations -design and operating experience, 3:26273
PIG ION SOURCES
See PENNING ION SOURCES

PILOT PLANTS/PUMPS
Coal liquefaction pilot plant, Cresap, West Virginia. Monthly technical progress report, September 1977, 3:25649 (FE-1517-55)
PILOT PLANTS/SEALS
Coal liquefaction pilot plant, Cresap, West Virginia. Monthly technical progress report, September 1977, 3:25649 (FE-1517-55)
PILOT PLANTS/VALVES
Coal liquefaction pilot plant, Cresap, West Virginia. Monthly technical progress report, September 1977, 3:25649 (FE-1517-55)
PINEAL GLAND/ELECTRON MICROSCOPY
Challenge of pineal gland structure and function (^{125}I tracer technique), 3:26983 (CONF-770504-)
PINEAL GLAND/MORPHOLOGY
Challenge of pineal gland structure and function (^{125}I tracer technique), 3:26983 (CONF-770504-)
PINEAL GLAND/PHYSIOLOGY
Challenge of pineal gland structure and function (^{125}I tracer technique), 3:26983 (CONF-770504-)
PINES/BIOCHEMISTRY
Biochemical basis of paraquat induced oleoresin production in pines, 3:26025 (SRO-0888-2)
PINS (FUEL)
See FUEL PINS
PION MINUS REACTIONS
Study of ^{3}He(π^-,N)^{2}H and ^{4}He(π^-,N)^{3}H at energies near the (3,3) resonance (Differential cross sections, mechanisms, 50 to 290 MeV), 3:27318 (ORO-4043-37)
PION MINUS REACTIONS/ABSORPTION
Study of pion-absorption mechanisms in ^{4}He and other nuclei, 3:27323
PION MINUS REACTIONS/CHARGE-EXCHANGE REACTIONS
Angular distribution of the (π^-,π^0) reaction on ^{3}He at 200 to 290 MeV, 3:27319 (ORO-4043-37)
PION MINUS REACTIONS/COULOMB SCATTERING
Single W-meson production in the scattering of hadrons in the Coulomb field of nuclei, 3:27234
PION MINUS REACTIONS/ELASTIC SCATTERING
Elastic scattering of π^{+-} on ^{3}He and ^{3}He (Differential cross sections, 233 to 300 MeV/C experiment in progress), 3:27320 (ORO-4043-37)
Neutron deformation parameter from comparative study of π^+ and π^- inelastic scattering, 3:27335
PION MINUS REACTIONS/INELASTIC SCATTERING
Neutron deformation parameter from comparative study of π^+ and π^- inelastic scattering, 3:27335
PION MINUS REACTIONS/KNOCK-OUT REACTIONS
Coincidence measurements of quasielastic pion scattering by ^{27}Al and ^{208}Pb, 3:27342
Neutron and proton knockout from ^{19}F and ^{27}Al by negative pions, 3:27329
PION MINUS REACTIONS/PRECOMPOUND-NUCLEUS EMISSION
Energetic charged particle yields induced by pions on complex nuclei (π^{+-} on ^{27}Al, ^{62}Ni, ^{181}Ta, 100 and 220 MeV: cross sections), 3:27360 (ANL-77-60)
Gamma rays from pion-induced reactions (^{62}Ni + π^-, 220 MeV: cross sections), 3:27359 (ANL-77-60)
PION MINUS REACTIONS/QUASI-ELASTIC SCATTERING
Coincidence measurements of quasielastic pion scattering by ^{27}Al and ^{208}Pb, 3:27342
PION MINUS REACTIONS/TOTAL CROSS SECTIONS
Pion cross section measurements on aligned ^{165}Ho in the (3,3) resonance region, 3:27375
PION MINUS-PROTON INTERACTIONS/DIFFERENTIAL CROSS SECTIONS
Cross sections and polarizations in the reactions $\pi^- p \rightarrow \Lambda K^0$ and $\pi^- p \rightarrow \Lambda K^{*0}(890)$ near the backward direction, from 3 to 6 GeV/c, 3:27142
PION MINUS-PROTON INTERACTIONS/INCLUSIVE INTERACTIONS
Comparison of inclusive charged-pion production in π^{+-} p interactions at 100 GeV/c, 3:27139
Inclusive Δ^{++} (1232) production in 200-GeV/c π^- p interactions, 3:27132
Inclusive production of neutral strange particles in 250-GeV/c π^- p interactions (Cross sections), 3:27145
PION MINUS-PROTON INTERACTIONS/PARTICLE PRODUCTION
Study of the reactions $\pi^- p \rightarrow \pi^+ \pi^- n$ and $\pi^- p \rightarrow K^+ K^- n$ at 1.98 and 2.41 GeV/c (S* pole parameters), 3:27143
PION MINUS-PROTON INTERACTIONS/POLARIZATION
Cross sections and polarizations in the reactions $\pi^- p \rightarrow \Lambda K^0$ and $\pi^- p \rightarrow \Lambda K^{*0}(890)$ near the backward direction, from 3 to 6 GeV/c, 3:27142
PION MINUS-PROTON INTERACTIONS/SCATTERING AMPLITUDES
Real parts of the pion-proton forward scattering amplitude, 3:27224
PION PLUS REACTIONS
Measurement of the ^{12}C(π^+, π^+ + p)^{11}B reaction cross section (Preliminary results, 100 and 130 MeV), 3:27333 (ORO-4043-37)
PION PLUS REACTIONS/ABSORPTION
Study of pion-absorption mechanisms in ^{4}He and other nuclei, 3:27323
PION PLUS REACTIONS/CHARGE-EXCHANGE REACTIONS
Properties of inclusive (π^+,π^0) reactions in nuclei, 3:27334
PION PLUS REACTIONS/COULOMB SCATTERING
Single W-meson production in the scattering of hadrons in the Coulomb field of nuclei, 3:27234
PION PLUS REACTIONS/ELASTIC SCATTERING
Elastic scattering of π^{+-} on ^{3}He and ^{3}He (Differential cross sections, 233 to 300 MeV/C experiment in progress), 3:27320 (ORO-4043-37)
Neutron deformation parameter from comparative study of π^+ and π^- inelastic scattering, 3:27335
PION PLUS REACTIONS/INELASTIC SCATTERING
Neutron deformation parameter from comparative study of π^+ and π^- inelastic scattering, 3:27335
PION PLUS REACTIONS/KNOCK-OUT REACTIONS
Coincidence measurements of quasielastic pion scattering by ^{27}Al and ^{208}Pb, 3:27342
PION PLUS REACTIONS/PRECOMPOUND-NUCLEUS EMISSION
Energetic charged particle yields induced by pions on complex nuclei (π^{+-} on ^{27}Al, ^{62}Ni, ^{181}Ta, 100 and 220 MeV: cross sections), 3:27360 (ANL-77-60)
PION PLUS REACTIONS/QUASI-ELASTIC SCATTERING
Coincidence measurements of quasielastic pion scattering by ^{27}Al and ^{208}Pb, 3:27342
PION PLUS REACTIONS/TOTAL CROSS SECTIONS
Pion cross section measurements on aligned ^{165}Ho in the (3,3) resonance region, 3:27375
PION PLUS-PROTON INTERACTIONS/DIFFRACTION MODELS
Kinematical enhancements due to pion diffraction dissociation into K anti K* and K anti *K: Spinless treatment, 3:27223
PION PLUS-PROTON INTERACTIONS/INCLUSIVE INTERACTIONS
Comparison of inclusive charged-pion production in π^{+-} p interactions at 100 GeV/c, 3:27139
PION PLUS-PROTON INTERACTIONS/MULTIPLE PRODUCTION
Search for $\pi^+ p \rightarrow$ D-bar$^0 C_1^{++}$ near threshold, 3:27141
PION PLUS-PROTON INTERACTIONS/SCATTERING AMPLITUDES
Real parts of the pion-proton forward scattering amplitude, 3:27224
PION REACTIONS/ELASTIC SCATTERING
Eikonal and quasi-eikonal models in the theory of complex angular momenta for pion elastic scattering and rho^0-meson photoproduction on ^{4}He nuclei, 3:27235
PION REACTIONS/FIELD THEORIES
Field theoretic treatment of π-nuclear scattering, 3:27391
PION REACTIONS/LOW EQUATION
Field theoretic treatment of π-nuclear scattering, 3:27391
PION REACTIONS/RESEARCH PROGRAMS
Experiments on the nuclear interactions of pions and electrons. Progress report, December 1, 1976-November 30, 1977 (Summaries of research activities at the University of Virginia), 3:27097 (ORO-4043-37)
PION-DEUTERON INTERACTIONS/ABSORPTION
Screening correction for hadron-deuteron absorption cross sections near 200 GeV/c, 3:27231
PION-DEUTERON INTERACTIONS/ELASTIC SCATTERING
Scattering of pions by deuterons at low and medium energies, 3:27230
PION-DEUTERON INTERACTIONS/MULTIPLE PRODUCTION
Charged-particle multiplicity distributions in 100-GeV/c pd, π^+ d, p-nucleon, and π-nucleon interactions, 3:27126
PION-DEUTERON INTERACTIONS/MULTIPLE SCATTERING
Coupled channel theory of pion-deuteron reaction applied to threshold scattering, 3:27317
PION-DEUTERON INTERACTIONS/NUCLEAR SCREENING
Screening correction for hadron-deuteron absorption cross sections near 200 GeV/c, 3:27231
PION-EXCHANGE MODEL
See OPE MODEL
PION-NUCLEON INTERACTIONS
See also PION-PROTON INTERACTIONS
PION-NUCLEON INTERACTIONS/FIELD THEORIES
Field theoretic treatment of π-nuclear scattering, 3:27391

PION-NUCLEON INTERACTIONS/MULTIPLE PRODUCTION
Charged-particle multiplicity distributions in 100-GeV/c pd, π^+ d, p-nucleon, and π-nucleon interactions, 3:27126
PION-NUCLEON INTERACTIONS/MULTIPLE SCATTERING
Field theoretic treatment of π-nuclear scattering, 3:27391
PION-NUCLEON INTERACTIONS/PARTICLE PRODUCTION
Study of final states in $\pi^- N \rightarrow \mu^+ \mu^- +$ hadrons at 225 GeV, 3:27144
PION-PROTON INTERACTIONS/ELASTIC SCATTERING
Recent developments in the theory of large transverse momentum processes, 3:27119 (SLAC-PUB-1806)
PION-PROTON INTERACTIONS/INCLUSIVE INTERACTIONS
Recent developments in the theory of large transverse momentum processes, 3:27119 (SLAC-PUB-1806)
PIONS
See also COSMIC PIONS
PIONS MINUS
PIONS PLUS
PIONS/ELECTROPRODUCTION
Electroproduction of inclusive pions at high Q^2 (Cross sections, feynmon scaling), 3:27104
PIONS/MULTIPLE PRODUCTION
Evidence against copious threshold pion production in heavy-ion collisions, 3:27122
PIONS MINUS/PARTICLE PRODUCTION
Comparison of inclusive charged-pion production in π^{+-} p interactions at 100 GeV/c, 3:27139
PIONS PLUS/PARTICLE PRODUCTION
Comparison of inclusive charged-pion production in π^{+-} p interactions at 100 GeV/c, 3:27139
PIPE FITTINGS/DESIGN
Pipe connection for high pressure and temperature loads (Patent), 3:26382
PIPELINES
See also ALASKA OIL PIPELINE
NATURAL GAS DISTRIBUTION SYSTEMS
PIPELINES/CONSTRUCTION
Economico-mathematical formulation of the problem of optimization of the construction of the linear part of oil pipelines, 3:25811
Profile of the Southern Feeder, 3:25865
PIPELINES/DESIGN
Efficiency of hydraulic shipment of highly viscous oils in channels of rectangular cross section, 3:25810
PIPELINES/MATERIALS
Hydrogen compatibility of structural materials for energy storage and transmission applications. Semiannual report, April 1, 1977-October 1, 1977, 3:25962 (SAND-77-8296)
PIPELINES/MATHEMATICAL MODELS
Economico-mathematical formulation of the problem of optimization of the construction of the linear part of oil pipelines, 3:25811
PIPELINES/OFFSHORE SITES
Ekofisk-Emden gas pipeline, 3:25864
PIPELINES/OPTIMIZATION
Economico-mathematical formulation of the problem of optimization of the construction of the linear part of oil pipelines, 3:25811
PIPELINES/THERMAL STRESSES
Movements and stress characteristics of LNG piping, 3:25867
PIPES/RUPTURES
Reflections on the assumption of pipe breaks in order to improve safety in nuclear power plants, 3:26464
PIPES/STRESS ANALYSIS
Evaluations of the piping system inelastic analysis computer program PIRAX2 (LMFBR), 3:26276 (AI-DOE-13216)
PLANARIA/BIOLOGICAL RADIATION EFFECTS
Biological effects of ionizing radiation at the molecular, cellular, and organismal levels. Triannual progress report, July 15, 1974-October 14, 1977, 3:26984 (TID-28055)
PLANT CELLS/PHOTOSYNTHESIS
Effect of light on respiration and development of photosynthetic cells. Progress report, June 1, 1976-August 31, 1977 (Chlamydomonas, Euglena, spinach, peas), 3:26969 (COO-3231-5)
PLANTS
See also ALGAE
BIOMASS
FUNGI
NICOTIANA
TREES
PLANTS/BIOLOGICAL RADIATION EFFECTS
Estimated inventory of plutonium and uranium radionuclides for vegetation in aged fallout areas, 3:26913 (NVO-171)
PLANTS/BIOMASS
Revegetation of a waste disposal site in the 200 areas of the Hanford Reservation, 3:26908 (PNL-2454)
PLANTS/COMMUNITIES
Biotic components, 3:25946 (PNL-2253)
PLANTS/CONTAMINATION
Radionuclides in air, water, and biota (^{40}K, ^{7}Be, ^{137}Cs), 3:26934 (TID-26712)
PLANTS/ECOLOGY
Terrestrial plant ecology, 3:26902 (TID-26712)
PLANTS/POLLUTION
Environmental effect of mercury, with particular attention to the Monte Amiata Zone, 3:26885 (ORNL-tr-4479)
PLANTS/RADIATION MONITORING
Revegetation of a waste disposal site in the 200 areas of the Hanford Reservation, 3:26908 (PNL-2454)
PLANTS/RADIONUCLIDE KINETICS
Applications to waste management operations (Terrestrial ecosystems), 3:25951 (PNL-2253)
Estimated inventory of plutonium and uranium radionuclides for vegetation in aged fallout areas, 3:26913 (NVO-171)
PLANTS/ROOT ABSORPTION
Influence of microbial activities on availability and biotransport of plutonium, 3:26916 (NVO-171)
PLANTS/TAXONOMY
Terrestrial plant ecology, 3:26902 (TID-26712)
PLANTS (INDUSTRIAL)
See INDUSTRIAL PLANTS
PLANTS (PILOT)
See PILOT PLANTS
PLANTS (POWER)
See POWER PLANTS
PLASMA
See also BEAM-PLASMA SYSTEMS
COLD PLASMA
COLLISIONAL PLASMA
COLLISIONLESS PLASMA
HIGH-BETA PLASMA
HOMOGENEOUS PLASMA
HOT PLASMA
INHOMOGENEOUS PLASMA
LASER-PRODUCED PLASMA
PLASMA/COMPRESSION
System of nonlinear partial differential equations describing cylindrical plasma collapse, 3:27506 (LA-6824)
PLASMA/COULOMB SCATTERING
Photon absorption and emission in Coulomb collisions in a magnetic field, 3:27529
PLASMA/DIFFUSION
Classical diffusion in the presence of an X point, 3:27638 (PPPL-EPRI-7)
PLASMA/EQUATIONS OF STATE
Experimental equation of state of a highly ionized cesium plasma, 3:27492
PLASMA/LINE BROADENING
Stark profiles of hydrogen lines in a plasma with a low-frequency turbulence, 3:27487
PLASMA/MATHEMATICAL MODELS
Statistical formulation of one-dimensional electron fluid turbulence, 3:27567
System of nonlinear partial differential equations describing cylindrical plasma collapse, 3:27506 (LA-6824)
PLASMA/MEETINGS
Proceedings of the 9. symposium on fusion technology, 3:27539 (EUR-5602)
PLASMA/MICROWAVE RADIATION
Kinetic theory of a resonance radiation of a magnetic plasma from an open periodic waveguide, 3:27581
PLASMA/REVIEWS
Effect of plasma on radiative sources, 3:27488
PLASMA/TURBULENCE
Analysis of the Dupree-Weinstock theory of a turbulent plasma in a magnetic field, 3:27503
Statistical formulation of one-dimensional electron fluid turbulence, 3:27567
PLASMA CONFINEMENT
Theory and calculations of non-magnetic dense-plasma confinement, 3:27458
PLASMA CONFINEMENT/REVIEWS
Summary of magnetic confinement (theory), 3:27456
PLASMA CONFINEMENT/SCALING LAWS
Scaling laws for plasma confinement, 3:27461
PLASMA DIAGNOSTICS/DOPPLER BROADENING
Spectroscopic measurements of ion temperature in ATC tokamak with RF and neutral-beam heating, 3:27478
PLASMA DIAGNOSTICS/ELECTRON DENSITY
Determination of electron density from the self-reversed deuterium D/sub b/line, 3:27476

PLASMA DIAGNOSTICS/EMISSION SPECTRA
Laser-produced dense plasma diagnostics based on spectra of hydrogen-like and helium-like multicharged ions, 3:27692
PLASMA DIAGNOSTICS/ENERGY SPECTRA
Resolution of thin foils applicable in corpuscular plasma diagnostic, 3:27479
PLASMA DIAGNOSTICS/FARADAY CUPS
Electrostatic diagnostics of JFT-2a (DIVA), 3:27467 (JAERI-M-6861)
PLASMA DIAGNOSTICS/LASER RADIATION
Scattering of argon laser radiation for low-temperature plasma diagnostics, 3:27475
PLASMA DIAGNOSTICS/MAGNETIC PROBES
Detection of the position and cross-section of a tokamak plasma with magnetic probes, 3:27468 (JAERI-M-6931)
PLASMA DIAGNOSTICS/OPTICAL SYSTEMS
Multichannel Thomson scattering apparatus, 3:27472
PLASMA DIAGNOSTICS/PROBES
Noncontact conductivity measurement, 3:27480
PLASMA DIAGNOSTICS/RESEARCH PROGRAMS
TFTR diagnostic development (9C). First quarterly report, October-December 1977, 3:27470 (TID-27931)
PLASMA DIAGNOSTICS/STARK EFFECT
Determination of electron density from the self-reversed deuterium D/sub b/line, 3:27476
Stark profile measurements on Lyman series lines of Al XIII, 3:27471
PLASMA DIAGNOSTICS/X-RAY DETECTION
Diagnosis of laser fusion targets, 3:27677 (UCRL-52000-77-8)
Study of disruptive instabilities in the PLT Tokamak using x-ray techniques, 3:27469 (PPPL-1379)
PLASMA DIAGNOSTICS/X-RAY RADIOGRAPHY
High resolution time resolvable flash x-radiography system, 3:27670 (SAND-77-1587C)
PLASMA DIAGNOSTICS/X-RAY SPECTRA
Fast-electron production in laser-heated plasmas, 3:27477
PLASMA DIAGNOSTICS/X-RAY SPECTROSCOPY
Direct measurement of compression of laser-imploded targets using x-ray spectroscopy, 3:27474
PLASMA DRIFT/PLASMA MICROINSTABILITIES
Anomalous transport in high-temperature plasmas with applications to solenoidal fusion systems, 3:27556
PLASMA DRIFT/TRANSPORT THEORY
Modification of Pfirsch-Schlueter transport by poloidally asymmetric sources, 3:27512
PLASMA DRIFT/TURBULENCE
Renormalized dielectric function for collisionless drift wave turbulence, 3:27509
PLASMA FILAMENT/CONTROL SYSTEMS
Stability of plasma column position control system, 3:27498
PLASMA FOCUS/NEUTRON EMISSION
Neutron production in the dense plasma focus, 3:27484
Some properties of the neutron yield in a low-energy plasma focus, 3:27493
Space-time structure of neutron and X-ray sources in a plasma focus, 3:27483
PLASMA FOCUS/PLASMA SHEATH
Experimental verification of a theory of the current sheath in the plasma focus, 3:27485
Magnetic tension and thickness in the current sheath dynamics, 3:27495
PLASMA FOCUS/X-RAY EMISSION ANALYSIS
Space-time structure of neutron and X-ray sources in a plasma focus, 3:27483
PLASMA FOCUS DEVICES/SPECIFICATIONS
Preliminary results of the 1-MJ plasma focus experiment, 3:27496
PLASMA HEATING
See also HIGH-FREQUENCY HEATING
LASER-RADIATION HEATING
TURBULENT HEATING
Rapid further heating of tokamak plasma by fast-rising magnetic pulse, 3:27453
PLASMA HEATING/ALPHA PARTICLES
Dynamic characteristics of alpha-particle heating based upon the Fokker-Planck equation in D-T fusion reactor core plasmas, 3:27457
PLASMA HEATING/ALPHA REACTIONS
Approximate theory of steady-state and dynamic characteristics of alpha-particle-heated DT-fusion reactors, 3:27462
PLASMA HEATING/REVIEWS
Heating of toroidal plasmas, 3:27426 (CEA-CONF-3863)
PLASMA INSTABILITY
See also CONVECTIVE INSTABILITIES
PARAMETRIC INSTABILITIES
PLASMA MACROINSTABILITIES
PLASMA MICROINSTABILITIES
TRAPPED-PARTICLE INSTABILITY
TWO-STREAM INSTABILITY
PLASMA INSTABILITY/ANALYTICAL SOLUTION
Annual progress report (Linear and nonlinear instabilities), 3:27538 (COO-3497-24)
PLASMA INSTABILITY/NONLINEAR PROBLEMS
Linear and non-linear calculation of the tearing mode in reversed field pinches, 3:27560
PLASMA MACROINSTABILITIES
See also KINK INSTABILITY
TRAPPED-PARTICLE INSTABILITY
Theory of the ubiquitous mode, 3:27555
Toroidal MHD stability in complex magnetic configurations, 3:27515
PLASMA MACROINSTABILITIES/INSTABILITY GROWTH RATES
Energy principles for non-ideal MHD, 3:27551
Magnetohydrodynamic equilibria and local stability of axisymmetric tokamak plasmas, 3:27437
PLASMA MACROINSTABILITIES/STABILIZATION
Ballooning instabilities in toroidally linked mirror systems, 3:27558
PLASMA MICROINSTABILITIES
See also CYCLOTRON INSTABILITY
DRIFT INSTABILITY
TWO-STREAM INSTABILITY
Anomalous transport in high-temperature plasmas with applications to solenoidal fusion systems, 3:27556
Kinetic and numerical studies of microstability properties and anomalous transport in theta pinches, 3:27549
PLASMA MICROINSTABILITIES/RESEARCH PROGRAMS
Annual progress report (Linear and nonlinear instabilities), 3:27538 (COO-3497-24)
PLASMA PRODUCTION/ELECTRIC ARCS
High-power electric-arc generators of low-temperature plasma, 3:27534
PLASMA PRODUCTION/SHOCK WAVES
Crowbar experiments by ionizing shock waves and new methods, 3:27530 (EUR-5602)
PLASMA SEEDING/SIMULATION
Testing and evaluation of MHD materials and substructures. Quarterly technical progress report, January-March 1977, 3:26538 (FE-2246-3(Rev.A))
PLASMA SIMULATION/ADIABATIC PROCESSES
Quasi-neutral particle simulation model with application to ion wave propagation, 3:27570
PLASMA WAVES
See also ELECTRON PLASMA WAVES
ION ACOUSTIC WAVES
PLASMA WAVES/DAMPING
Theoretical investigations relevant to magnetic fusion energy research. Progress report, January 1, 1977-January 1, 1978, 3:27537 (CONF-771136-25)
PLASMA WAVES/DISPERSION RELATIONS
Self-motion and collective behaviour of classical one-component plasmas, 3:27579
PLASMA WAVES/EXCITATION
Measurements of the parametric decay of CO_2-laser radiation into plasma waves at quarter-critical density using ruby-laser Thomson scattering, 3:27440
PLASMA WAVES/HYBRID RESONANCE
Heating tokamaks via the ion-cyclotron and ion-ion hybrid resonances, 3:27584
Plasma turbulence near the low hybrid resonance, 3:27588
PLASMA WAVES/MODULATION
Non-linear Langmuir wave modulation in collisionless plasma, 3:27575
PLASMA WAVES/NONLINEAR PROBLEMS
Wave-wave interactions in a plasma, 3:27591
PLASMA WAVES/RAMAN EFFECT
Effects of beat-wave electron trapping on stimulated Raman and Thomson scattering, 3:27569
PLASMA WAVES/STOCHASTIC PROCESSES
Phase stochastization mechanism and wave turbulence structure in dissipative media, 3:27587
PLASMA WAVES/THOMSON SCATTERING
Effects of beat-wave electron trapping on stimulated Raman and Thomson scattering, 3:27569
PLASMA WAVES/TRAPPING
Effects of beat-wave electron trapping on stimulated Raman and Thomson scattering, 3:27569
PLASMA WAVES/TURBULENCE
Phase stochastization mechanism and wave turbulence structure in dissipative media, 3:27587
Plasma turbulence near the low hybrid resonance, 3:27588
PLASMA WAVES/WAVE PROPAGATION
Contribution of the second order terms to the nonlinear shallow water waves, 3:27565 (IPPJ-253)
PLASTIC SCINTILLATION DETECTORS/CALIBRATION
Calibration of a detector for pulsed neutron sources, 3:26819 (LA-7022-MS)

PLATINUM/CATALYTIC EFFECTS
Hydrogenation of hexene over platinum on alumina vs. platinum in a Na-Y zeolite, 3:26684
PLATINUM/COSTER-KRONIG TRANSITIONS
L shell fluorescence yields and Coster-Kronig transition probabilities using radioactive sources. Final report, 3:27056 (AD-A-042228)
PLATINUM/ION EXCHANGE
Cation exchange of 53 elements in nitric acid, 3:26665 (LA-7083)
PLATINUM/X-RAY SPECTRA
L shell fluorescence yields and Coster-Kronig transition probabilities using radioactive sources. Final report, 3:27056 (AD-A-042228)
PLATINUM COMPLEXES/BOND LENGTHS
Determination of local structures of platinum uridine blues and purples by extended x-ray absorption fine structure spectroscopy, 3:26675
PLATINUM COMPLEXES/STRUCTURAL CHEMICAL ANALYSIS
Single crystal neutron diffraction studies of partially oxidized $K_2Pt(CN)_4Br_{0.3}.3.0H_2O$, $K_2Pt(CN)_4Cl_{0.3}.3.0H_2O$, and $K_{1.75}Pt(CN)_4.1.5H_2O$: new results and a summary, 3:26682
PLATINUM COMPOUNDS/CATALYTIC EFFECTS
Catalytic reforming of naphtha cuts over polymetallic catalysts, 3:25772
PLOTTERS/COMPUTER CODES
Installation independent version of the Sandia SCORS plot system, 3:27706 (SAND-77-1179)
PLT DEVICES
(Princeton Large Torus.)
PLT DEVICES/ELECTRON DENSITY
Multichannel Thomson scattering apparatus, 3:27472
PLT DEVICES/ELECTRON TEMPERATURE
Multichannel Thomson scattering apparatus, 3:27472
PLT DEVICES/IMPURITIES
Calculations of impurity radiation and its effects on tokamak experiments, 3:27627
PLT DEVICES/PLASMA INSTABILITY
Study of disruptive instabilities in the PLT Tokamak using x-ray techniques, 3:27469 (PPPL-1379)
PLT DEVICES/WALL LOADING
Fusion product bombardment of a tokamak first wall, 3:27626
PLT DEVICES/X-RAY DETECTION
Study of disruptive instabilities in the PLT Tokamak using x-ray techniques, 3:27469 (PPPL-1379)
PLUGS
See CLOSURES
PLUTONIUM/ENVIRONMENTAL TRANSPORT
Influence of microbial activities on availability and biotransport of plutonium, 3:26916 (NVO-171)
PLUTONIUM 237/ENVIRONMENTAL TRANSPORT
Radionuclide transport (Hanford terrestrial ecosystems), 3:25948 (PNL-2253)
PLUTONIUM 238/ENVIRONMENTAL TRANSPORT
Estimated inventory of plutonium and uranium radionuclides for vegetation in aged fallout areas, 3:26913 (NVO-171)
Plutonium distribution in a desert pavement-desert mound soil system in area 11, 3:26910 (NVO-171)
PLUTONIUM 238/TISSUE DISTRIBUTION
Solubility of plutonium and americium-241 from rumen contents of cattle grazing on plutonium-contaminated desert vegetation in in vitro bovine gastrointestinal fluids, November 1974-May 1975 (Uptake of transuranics by dairy cows from contaminated forage with emphasis on excretion in milk), 3:26914 (NVO-171)
PLUTONIUM 239/BIOLOGICAL RADIATION EFFECTS
^{239}Pu and ^{241}Am contamination of small vertebrates in NAEG study areas of NTS and TTR, 3:26915 (NVO-171)
Estimated inventory of plutonium and uranium radionuclides for vegetation in aged fallout areas, 3:26913 (NVO-171)
PLUTONIUM 239/DECONTAMINATION
Estimated inventory of plutonium and uranium radionuclides for vegetation in aged fallout areas, 3:26913 (NVO-171)
PLUTONIUM 239/ENVIRONMENTAL TRANSPORT
Ecology of Hanford 200 Area and 1976 radionuclide inventory, 3:25944 (PNL-2253)
Estimated inventory of plutonium and uranium radionuclides for vegetation in aged fallout areas, 3:26913 (NVO-171)
Initial synthesis of area 13 ^{239}Pu data and other statistical analyses (^{239}Pu and ^{240}Pu distribution in soil and biological samples from Nevada Test Site), 3:26912 (NVO-171)
Plutonium distribution in a desert pavement-desert mound soil system in area 11, 3:26910 (NVO-171)
Plutonium distribution in the environs of the Nevada Test Site: status report, 3:26911 (NVO-171)
Radionuclide transport (Hanford terrestrial ecosystems), 3:25948 (PNL-2253)
PLUTONIUM 239/ROOT ABSORPTION
Estimated inventory of plutonium and uranium radionuclides for vegetation in aged fallout areas, 3:26913 (NVO-171)
PLUTONIUM 239/TISSUE DISTRIBUTION
Solubility of plutonium and americium-241 from rumen contents of cattle grazing on plutonium-contaminated desert vegetation in in vitro bovine gastrointestinal fluids, November 1974-May 1975 (Uptake of transuranics by dairy cows from contaminated forage with emphasis on excretion in milk), 3:26914 (NVO-171)
PLUTONIUM 239/WHOLE-BODY COUNTING
Realistic calibration of whole body counters for measuring plutonium, 3:26817 (IAEA-SM-222/57)
PLUTONIUM 240/BIOLOGICAL RADIATION EFFECTS
Estimated inventory of plutonium and uranium radionuclides for vegetation in aged fallout areas, 3:26913 (NVO-171)
PLUTONIUM 240/ENVIRONMENTAL TRANSPORT
Estimated inventory of plutonium and uranium radionuclides for vegetation in aged fallout areas, 3:26913 (NVO-171)
Initial synthesis of area 13 ^{239}Pu data and other statistical analyses (^{239}Pu and ^{240}Pu distribution in soil and biological samples from Nevada Test Site), 3:26912 (NVO-171)
Plutonium distribution in a desert pavement-desert mound soil system in area 11, 3:26910 (NVO-171)
PLUTONIUM 240/ROOT ABSORPTION
Estimated inventory of plutonium and uranium radionuclides for vegetation in aged fallout areas, 3:26913 (NVO-171)
PLUTONIUM 240 TARGET/NEUTRON REACTIONS
Fission of ^{240}Pu with 14.8-MeV neutrons, 3:27381
PLUTONIUM CARBIDES/CHEMICAL RADIATION EFFECTS
Chemical state of irradiated carbide fuel pins (LMFBR), 3:26641
PLUTONIUM CARBIDES/CREEP
Creep behavior of mixed-carbide advanced nuclear fuel (LMFBR), 3:26635
PLUTONIUM CARBIDES/MECHANICAL PROPERTIES
Fuel properties of advanced fuels (U,Pu)CN important for out-of-pile and in-pile kinetics (LMFBR), 3:26634
PLUTONIUM CARBIDES/PHYSICAL RADIATION EFFECTS
Analytical comparison of the irradiation behavior of fast reactor carbide and oxide fuel pins (LMFBR), 3:26319
Chemical state of irradiated carbide fuel pins (LMFBR), 3:26641
CNEN program on advanced LMFBR fuels, 3:26299
Correlation between properties and irradiation behavior for carbide, carbonitride and nitride fuels (LMFBR), 3:26316
French irradiation test experience for carbide fuels (LMFBR), 3:26309
German carbide irradiation test experience for fast reactors (LMFBR), 3:26308
Irradiation behavior of sphere-pac carbide fuel (LMFBR), 3:26310
Irradiation experiments of uranium carbide, carbonitride, and nitride fuels in JAERI (LMFBR), 3:26311
Irradiation performance analysis of UK fast reactor fuel (LMFBR), 3:26317
Progress in modeling carbide and nitride fuel performance in advanced LMFBRs, 3:26318
UK irradiation experience relevant to advanced carbide fuel concepts for LMFBR's, 3:26307
US advanced LMFBR fuels development program, 3:26293
PLUTONIUM CARBIDES/THERMODYNAMIC PROPERTIES
Some observations on oxygen and carbon potentials in U-Pu-O and U-Pu-C systems (LMFBR), 3:26599
PLUTONIUM DIOXIDE/CHEMICAL RADIATION EFFECTS
US-UK technical exchange breeder reactor fuels: fuel pin chemistry, 3:26282 (HEDL-6297)
PLUTONIUM DIOXIDE/PHYSICAL RADIATION EFFECTS
Analytical comparison of the irradiation behavior of fast reactor carbide and oxide fuel pins (LMFBR), 3:26319
CNEN program on advanced LMFBR fuels, 3:26299
Experience and future plan of fast reactor oxide fuels irradiation in Japan, 3:26301
Irradiation performance analysis of UK fast reactor fuel (LMFBR), 3:26317
LIFE code system for analysis of oxide fuel pin thermal/structural behavior (LMFBR), 3:26320
Mechanical behavior of a fuel pin for fast reactors: effect of the fuel form and of the approach-to-power on the change of the fuel stack length under irradiation, 3:26302
Properties and irradiation behavior of advanced oxide particle fuel (LMFBR, BWR, PWR), 3:26305
UK irradiation experience relevant to advanced oxide fuel concepts for LMFBR's, 3:26300
US advanced LMFBR fuels development program, 3:26293
US experience in irradiation testing of advanced oxide fuels (LMFBR), 3:26303
PLUTONIUM DIOXIDE/THERMODYNAMIC PROPERTIES
Some observations on oxygen and carbon potentials in U-Pu-O and U-Pu-C systems (LMFBR), 3:26599
PLUTONIUM ISOTOPES/RADIATION MONITORING
Revegetation of a waste disposal site in the 200 areas of the Hanford Reservation, 3:26908 (PNL-2454)
PLUTONIUM NITRIDES/MECHANICAL PROPERTIES
Fuel properties of advanced fuels (U,Pu)CN important for out-of-pile and in-pile kinetics (LMFBR), 3:26634

PLUTONIUM NITRIDES/PHYSICAL RADIATION EFFECTS
Correlation between properties and irradiation behavior for carbide, carbonitride and nitride fuels (LMFBR), 3:26316
Irradiation experiments of uranium carbide, carbonitride, and nitride fuels in JAERI (LMFBR), 3:26311
Mixed-nitride fuel performance in EBR-II (LMFBR), 3:26306
Progress in modeling carbide and nitride fuel performance in advanced LMFBRs, 3:26318
US advanced LMFBR fuels development program, 3:26293
PLUTONIUM OXIDES/DISSOLUTION
Design and operation of air-lift, circulated, cascade dissolver systems, 3:26667 (RFP-2716)
PNEUMATIC TRANSPORT/PRESSURE DROP
Preparation of a coal conversion systems technical data book. Project 8979 monthly status report, November 1-November 30, 1977, 3:25615 (FE-2286-25)
POLLUTION
(For nonradioactive pollution only; see also CONTAMINATION.)
See also AIR POLLUTION
CHEMICAL EFFLUENTS
LAND POLLUTION
THERMAL POLLUTION
WATER POLLUTION
POLLUTION/MONITORING
Remote sensing using tunable lasers, 3:26870 (AED-Conf-77-165-002)
POLLUTION/REMOTE SENSING
Remote sensing using tunable lasers, 3:26870 (AED-Conf-77-165-002)
POLLUTION CONTROL EQUIPMENT
See also AIR FILTERS
SCRUBBERS
Development of high temperature dust collector. I, 3:26569
POLLUTION CONTROL EQUIPMENT/BIBLIOGRAPHIES
Oil water separators (a bibliography with abstracts). Report for 1964-Nov 77, 3:25804 (NTIS/PS-77/1004)
POLLUTION CONTROL EQUIPMENT/ENERGY CONSUMPTION
Energy consumption of environmental controls: fossil fuel, steam electric generating industry. Final report, 3:26193 (PB-273019)
POLLUTION CONTROL EQUIPMENT/PERFORMANCE
OPC-3000 coalescing plate oil/water separator evaluation. Technical memo, 3:25799 (AD-A-046123)
POLLUTION LAWS/ENFORCEMENT
State air pollution implementation plan. Progress report, July 1-December 31, 1974, 3:26877 (EPA-450/2-75-003)
POLONIUM/ION EXCHANGE
Cation exchange of 53 elements in nitric acid, 3:26665 (LA-7083)
POLONIUM 210/ENVIRONMENTAL TRANSPORT
Distribution of some chemical elements between dissolved and particulate phases in the ocean. Period covered: August 1, 1976-October 31, 1977 (Natural ^{210}Pb and ^{210}Po tracers), 3:26930 (COO-3566-19)
POLYACRYLATES/CHEMICAL RADIATION EFFECTS
Radiation degradation susceptibility of several related polymers. Research and development technical report, 3:26693 (AD-A-042525)
POLYATOMIC MOLECULES/DISSOCIATION
Design of natural collision coordinates to describe dissociation of polyatomic molecules, 3:27067
Is multiphoton dissociation of molecules a statistical thermal process, 3:27047
POLYATOMIC MOLECULES/EXCITATION
Is multiphoton dissociation of molecules a statistical thermal process, 3:27047
POLYMERS
See also ORGANIC POLYMERS
POLYMERS/MECHANICAL PROPERTIES
Consideration of encapsulants for photovoltaic arrays in terrestrial applications, 3:25999
POLYPEPTIDES/BIOCHEMISTRY
Catalytic and structural properties of the pentafunctional/arom/enzyme conjugate, 3:26944 (CONF-780108-1)
POLYURETHANES/PRODUCTION
Studies on defect occurrence of LPG tank insulation executed in winter, 3:25866
POMERANCHUK PARTICLES/BOOTSTRAP MODEL
Rising cross section and the multi-Pomeron bootstrap, 3:27286
POMERANCHUK PARTICLES/EXCHANGE INTERACTIONS
Colliding pomerons-experimental situation and outlook (Review), 3:27120 (TID-28065)
POMERANCHUK PARTICLES/PARTICLE PRODUCTION
Generation of a Pomeron and an f Regge pole in the dual-unitarization program, 3:27209
POMERONS
See POMERANCHUK PARTICLES
PONDS
See also COOLING PONDS
See LAKES
PONDS/RADIOACTIVE WASTE DISPOSAL
Revegetation of a waste disposal site in the 200 areas of the Hanford Reservation, 3:26908 (PNL-2454)
PONDS (COOLING)
See COOLING PONDS
POROUS MATERIALS/FLUID FLOW
Pressure drop and flow distribution of a polymer solution in a non-homogeneous porous medium, 3:25752
POROUS MATERIALS/FRACTURING
Calculation of two-phase flow and fracturing in a porous medium (abstract), 3:26085
POROUS MATERIALS/PERMEABILITY
Calculation of two-phase flow and fracturing in a porous medium (abstract), 3:26085
POROUS MATERIALS/TWO-PHASE FLOW
Calculation of two-phase flow and fracturing in a porous medium (abstract), 3:26085
PORPHYRINS
See also CHLOROPHYLL
PORPHYRINS/MOLECULAR STRUCTURE
Peripheral metal complexes: chlorophyll "isomers" with magnesium bound to the ring E β-keto ester system, 3:26674
POSITION INDICATORS
See DISPLACEMENT GAGES
POSITRON CAMERAS/PERFORMANCE TESTING
Biomedical research and application utilizing cyclotron produced radionuclides. Progress report, January 1 1977-December 31, 1977, 3:26971 (COO/4268-1)
POSITRONIUM/COULOMB FIELD
Breakup of relativistic positronium in the field of an atom, 3:27063
POSITRONIUM/DECAY
Breakup of relativistic positronium in the field of an atom, 3:27063
POSITRONS/PARTICLE PRODUCTION
Observation of μe events in anti ν and ν interactions in neon, 3:27114
POTASSIUM/ABUNDANCE
Rare earth and other trace elements in historic Azorean lavas, 3:27009
POTASSIUM/ATOM-MOLECULE COLLISIONS
Ionizing collisions of cesium and potassium atoms with water, 3:27066
POTASSIUM 39/HIGH SPIN STATES
High-spin states in A $\simeq$ 40 nuclei: Data for ^{38}Ar and ^{39}K, 3:27346
POTASSIUM 40/ENVIRONMENTAL EFFECTS
Radionuclides in air, water, and biota (^{40}K, ^{7}Be, ^{137}Cs), 3:26934 (TID-26712)
POTASSIUM CHLORIDES/CHEMICAL REACTION KINETICS
Concentration dependence of activation free energies in electrolyte diffusion (abstract), 3:26115
POTASSIUM CHLORIDES/DIFFUSION
Concentration dependence of activation free energies in electrolyte diffusion (abstract), 3:26115
POWER
See also ELECTRIC POWER
NUCLEAR POWER
How Germany came to have nuclear energy: a stop half-way, 3:26336
POWER DEMAND
See also DEMAND FACTORS
POWER DEMAND/FORECASTING
Supplement to "Technical Documentation of Staff Procedures for Estimating Peak Demand", 3:26527
POWER DEMAND/SIMULATION
Methodology for predicting the demand for new electricity-using goods. Final report, 3:26498 (EPRI-EA-593)
POWER DENSITY/TWO-DIMENSIONAL CALCULATIONS
FLEX: a code for calculating neutron flux microdistributions in lattices consisting of hexagonal fuel assemblies, 3:26346
POWER DISTRIBUTION/RESEARCH PROGRAMS
Digest of current research in the electric utility industry (3000 entries), 3:26521 (EPRI-RD-3)
POWER EXCURSIONS
See EXCURSIONS
POWER GENERATION/MATERIALS
Role of materials in energy production, 3:26593
POWER GENERATION/RESEARCH PROGRAMS
Digest of current research in the electric utility industry (3000 entries), 3:26521 (EPRI-RD-3)
POWER PLANTS
See also DUAL-PURPOSE POWER PLANTS
FUEL CELL POWER PLANTS
HYDROELECTRIC POWER PLANTS
NUCLEAR POWER PLANTS
POWER PLANTS/CORROSION PROTECTION
Protection of steel and zinc-alloyed steel in power plants with Goldschmidt-products, 3:26186

POWER PLANTS/ENERGY LOSSES
Strategy for energy conservation through tribology, 3:26706 (TID-28175)
POWER PLANTS/LOAD MANAGEMENT
Automation of a power block with combined circulation of a medium in the boiler under normal operating and emergency load-shedding conditions, 3:26176
Electric power from containers, 3:26181
POWER REACTORS
See also BRUCE-1 REACTOR
BRUCE-2 REACTOR
BRUCE-3 REACTOR
BRUCE-4 REACTOR
CALHOUN-1 REACTOR
CHEROKEE-1 REACTOR
CHEROKEE-2 REACTOR
CHEROKEE-3 REACTOR
CLINCH RIVER BREEDER REACTOR
DRESDEN-1 REACTOR
DRESDEN-2 REACTOR
DRESDEN-3 REACTOR
EBR-2 REACTOR
FESSENHEIM-2 REACTOR
GREIFSWALD-2 REACTOR
KOEBERG-1 REACTOR
LINGEN REACTOR
MUELHEIM-KAERLICH REACTOR
PAKS-1 REACTOR
PERKINS-1 REACTOR
PERKINS-2 REACTOR
PERKINS-3 REACTOR
PHILIPPSBURG-1 REACTOR
PHILIPPSBURG-2 REACTOR
PICKERING-1 REACTOR
PICKERING-2 REACTOR
PICKERING-3 REACTOR
PICKERING-4 REACTOR
PROCESS HEAT REACTORS
THTR-300 REACTOR
VRAIN REACTOR
WWER TYPE REACTORS
ZARNOWIEC REACTOR
POWER REACTORS/BIOLOGICAL SHIELDS
Nuclear reactor (Patent), 3:26478
POWER REACTORS/FUEL ASSEMBLIES
Spacer for nuclear reactor fuel rods, 3:26398
POWER REACTORS/PRESSURE VESSELS
Application of acoustic emission analysis during loading of a pressure vessel by pulsating internal pressure, 3:26360
Guiding device for a manipulator mast for internal inspection of a reactor pressure vessel (Patent), 3:26365
Rotation-symmetrical container with insulating cover (Patent), 3:26366
Screwing and holding device for lock nuts, especially for screwed joints of reactor pressure vessels (Patent), 3:26369
Stud tensioner for opening and closing the head of a reactor pressure vessel (Patent), 3:26375
Underclad cracking in nuclear vessel steels, 3:26359
POWER REACTORS/REACTOR CONTROL SYSTEMS
Experiments in connection with control of boron acid concentration by ion exchange in Hungary, 3:26408
POWER REACTORS/REACTOR INTERNALS
Instrumentation for the measurement of vibration in severe environments, such as nuclear reactors, 3:26374
POWER SUPPLIES/DESIGN
Design study of electrical power supply system for tokamak fusion power reactor, 3:27649 (JAERI-M-6803)
POWER SUPPLIES/SPECIFICATIONS
JET power supply comprehensive system, 3:27646 (EUR-5602)
POWER SUPPLIES/SWITCHES
Results of research into superconducting switches with high specific switching capacity, 3:27650 (LA-tr-78-13)
POWER SYSTEMS
See also AC SYSTEMS
DC SYSTEMS
POWER SYSTEMS/ELECTRICAL FAULTS
Characteristics of fault locating instruments, 3:26199
POWER SYSTEMS/LOAD MANAGEMENT
Electric power load management (citations from the NTIS data base). Report for 1964-July 1977, 3:26197 (NTIS/PS-77/0690)
POWER SYSTEMS/PLANNING
Regional power systems planning: a state of the art assessment. Interim report, survey of planning models, 3:26524 (ORO/5468-1)
POWER SYSTEMS/REGIONAL ANALYSIS
Regional power systems planning: a state of the art assessment. Interim report, survey of planning models, 3:26524 (ORO/5468-1)
POWER TRANSMISSION/RESEARCH PROGRAMS
Digest of current research in the electric utility industry (3000 entries), 3:26521 (EPRI-RD-3)
POWER-COOLING-MISMATCH ACCIDENTS/FILM BOILING
Response of unirradiated and irradiated PWR fuel rods tested under power-cooling-mismatch conditions, 3:26443 (TREE-NUREG-1196)
POWER-COOLING-MISMATCH ACCIDENTS/HEAT TRANSFER
Response of unirradiated and irradiated PWR fuel rods tested under power-cooling-mismatch conditions, 3:26443 (TREE-NUREG-1196)
PRASEODYMIUM COMPOUNDS/KNIGHT SHIFT
Systematics in the Knight shift of rare-earth monopnictides, 3:26600
PRECIPITATIONS (ATMOSPHERIC)
See ATMOSPHERIC PRECIPITATIONS
PRESSURE SUPPRESSION/TEST FACILITIES
Instrumenting a pressure suppression experiment for a MK I boiling water reactor: another measurements engineering challenge, 3:26444 (UCRL-52314)
PRESSURE TUBES/ULTRASONIC TESTING
Non-rotating device for in-situ inspection of pressure tube in CANDU nuclear reactors, 3:26271
PRESSURE VESSELS
Novel design for PWR pressure vessels, 3:26238
PRESSURE VESSELS/ACOUSTIC EMISSION TESTING
Application of acoustic emission analysis during loading of a pressure vessel by pulsating internal pressure, 3:26360
Structural integrity of fiber/epoxy vessels by acoustic emission, 3:26708
PRESSURE VESSELS/ACOUSTIC MONITORING
Application of acoustic emission techniques to integrity assessment of nuclear reactor components, 3:26371
Ultrasonic wave generator (Patent), 3:26377
PRESSURE VESSELS/CLOSURES
Nuclear reactor (Patent), 3:26225
Screwing and holding device for lock nuts, especially for screwed joints of reactor pressure vessels (Patent), 3:26369
PRESSURE VESSELS/CRACKS
Underclad cracking in nuclear vessel steels, 3:26359
PRESSURE VESSELS/ELASTICITY
Dynamical behavior of industrial structures made of reinforced concrete, 3:26384
PRESSURE VESSELS/FAILURES
Structural integrity of water reactor pressure boundary components. Progress report for period ending 28 February 1977, 3:26430 (AD-A-042219)
PRESSURE VESSELS/FASTENERS
Device for ultrasonic material testing of bolts having an axial through hole, preferably stud bolts of nuclear reactor pressure vessels (Patent), 3:26385
Stud tensioner for opening and closing the head of a reactor pressure vessel (Patent), 3:26375
PRESSURE VESSELS/FRACTURE PROPERTIES
Structural integrity of fiber/epoxy vessels by acoustic emission, 3:26708
PRESSURE VESSELS/INSPECTION
Guiding device for a manipulator mast for internal inspection of a reactor pressure vessel (Patent), 3:26365
PRESSURE VESSELS/MATERIALS
Hydrogen compatibility of structural materials for energy storage and transmission applications. Semiannual report, April 1, 1977-October 1, 1977, 3:25962 (SAND-77-8296)
PRESSURE VESSELS/NOZZLES
Boiling Water Reactor feedwater nozzle/sparger interim program report. Supplement No. 2: fracture mechanic analysis of JAERI model pressure vessel test, 3:26437 (NEDO-21480-02)
PRESSURE VESSELS/REFRACTORIES
Improvement of the mechanical reliability of monolithic refractory linings for coal gasification process vessels. Bimonthly letter progress report, October-November 1977, 3:25630 (FE-2218-15)
PRESSURE VESSELS/REMOTE VIEWING EQUIPMENT
Guiding device for a manipulator mast for internal inspection of a reactor pressure vessel (Patent), 3:26365
PRESSURE VESSELS/THERMAL SHIELDS
Rotation-symmetrical container with insulating cover (Patent), 3:26366
PRESSURE VESSELS/ULTRASONIC TESTING
Ultrasonic inspection of the spherically shaped perforated areas of light water reactor pressure vessels, 3:26214
PRESSURE VESSELS/WELDED JOINTS
Device for welding pipes onto pressurized elements, like tube sheets, pressure vessels, headers and the like (Patent), 3:26380
PRESSURIZED WATER REACTORS
See PWR TYPE REACTORS

PRIMARY COOLANT CIRCUITS/BUBBLE GROWTH
Bubble dynamics in a superheated liquid (LMFBR), 3:26277 (ANL-77-20)
PRIMARY COOLANT CIRCUITS/COOLANT CLEANUP SYSTEMS
Plant engineering experience with primary water purification plants in nuclear power stations with pressurised and boiling water reactors, 3:26216
PRINCETON LARGE TORUS
See PLT DEVICES
PROCESS HEAT REACTORS
Energy from nuclear reactors. Pt. 6. The gas-cooled HTR: reactivation of coal, 3:26340
Steam only from small reactor looks more attractive than coal (Consolidated Nuclear Steam Generator), 3:26339
PROCESS HEAT REACTORS/COAL GASIFICATION
Energy from nuclear reactors. Pt. 8. Two coal gasification procedures using reactor heat - 70% conversion efficiency, 3:26260
PROCESS HEAT REACTORS/COMPARATIVE EVALUATIONS
Role for nuclear energy in the recovery of oil from the tar sands of Alberta, 3:25894
PROCESS HEAT REACTORS/HEAT PIPES
Reactor and advanced heat transfer technology, 3:26705 (LA-6807-PR)
PROCESSING (DATA)
See DATA PROCESSING
PROCESSING (WASTES)
See WASTE PROCESSING
PROGRAMMING
Use of general purpose software in casting solidification simulation, 3:26597
PROPADIENE
See ALLENE
PROPAGATION (WAVE)
See WAVE PROPAGATION
PROPANONE
See ACETONE
PROPORTIONAL COUNTERS
Selective single atom detection in a 10^{19} atom background, 3:27062
PROTEINS/BIOSYNTHESIS
Membrane biogenesis: an application of biochemistry and cytochemistry to electron microscopy, 3:26953 (CONF-770504-)
PROTON BEAMS/BEAM LUMINOSITY
Comparison of anti p anti p and pp luminosities at Fermilab, 3:27215 (ANL-HEP-CP-77-81)
PROTON BEAMS/BEAM NEUTRALIZATION
Neutralization of positive particle beams by electron trapping, 3:26795 (BNL-23655)
PROTON DETECTION/SURFACE BARRIER DETECTORS
Jupiter energetic particle experiment ESAD proton sensor design, 3:26818 (LA-7009-MS)
PROTON REACTIONS/CHARGE-EXCHANGE REACTIONS
Anomalous optical-model potential for sub-Coulomb protons for $89 < A < 130$, 3:27361
PROTON REACTIONS/COULOMB SCATTERING
Single W-meson production in the scattering of hadrons in the Coulomb field of nuclei, 3:27234
PROTON REACTIONS/ELASTIC SCATTERING
Elastic scattering of 1-GeV protons by nuclei, 3:27127
Statistical analysis of ^{4}He(p,p)^{4}He data, 3:27325
PROTON REACTIONS/ENERGY DEPENDENCE
Energy dependence of the ^{119}Sn(p,n)^{119}Sn(IAS) reaction, 3:27365
PROTON REACTIONS/FRAGMENTATION
Fragmentation of nuclei by high-energy particles, 3:27135
PROTON REACTIONS/INCLUSIVE INTERACTIONS
Empirical formula for inclusive proton spectra between 10 and 300 GeV, 3:27232
Inclusive production of Λ^0 hyperons by 300-GeV protons: A dependence, 3:27129
PROTON REACTIONS/INELASTIC SCATTERING
Pair decay of the 7.65-MeV level of ^{12}C, 3:27330
PROTON REACTIONS/MULTIPLE PRODUCTION
Energy dependence of the pseudorapidity distributions in proton-nucleus collisions between 50 and 200 GeV/c, 3:27124
PROTON REACTIONS/PARTICLE PRODUCTION
Search for a new short-lived particle in collisions of 70 GeV/c protons with emulsion nuclei, 3:27118
PROTON-ANTIPROTON INTERACTIONS
Comparison of anti p anti p and pp luminosities at Fermilab, 3:27215 (ANL-HEP-CP-77-81)
PROTON-ANTIPROTON INTERACTIONS/INCLUSIVE INTERACTIONS
Inclusive rho^0 and f^0 production in 100-GeV/c p anti p interactions, 3:27128
PROTON-ANTIPROTON INTERACTIONS/PARTICLE PRODUCTION
Quark-quark interactions at the p anti p Collider, 3:27207 (TID-28062)
PROTON-DEUTERON INTERACTIONS/ABSORPTION
Screening correction for hadron-deuteron absorption cross sections near 200 GeV/c, 3:27231
PROTON-DEUTERON INTERACTIONS/MULTIPLE PRODUCTION
Charged-particle multiplicity distributions in 100-GeV/c pd, π^+ d, p-nucleon, and π-nucleon interactions, 3:27126
PROTON-DEUTERON INTERACTIONS/NUCLEAR SCREENING
Screening correction for hadron-deuteron absorption cross sections near 200 GeV/c, 3:27231
PROTON-NUCLEON INTERACTIONS
See also PROTON-PROTON INTERACTIONS
PROTON-NUCLEON INTERACTIONS/MULTIPLE PRODUCTION
Charged-particle multiplicity distributions in 100-GeV/c pd, π^+ d, p-nucleon, and π-nucleon interactions, 3:27126
Possible mechanism of direct production of leptons in pN collisions, 3:27237
PROTON-PROTON INTERACTIONS
Comparison of anti p anti p and pp luminosities at Fermilab, 3:27215 (ANL-HEP-CP-77-81)
PROTON-PROTON INTERACTIONS/DIFFRACTION MODELS
Diffractive process in six-prong proton-proton interactions at 205 GeV/c, 3:27125
PROTON-PROTON INTERACTIONS/ELASTIC SCATTERING
Simultaneous measurement of the spin parameters P and C/sub N N/ in pp elastic scattering at 2, 3, 4, and 6 GeV/c, 3:27131
PROTON-PROTON INTERACTIONS/EXCHANGE INTERACTIONS
Colliding pomerons-experimental situation and outlook (Review), 3:27120 (TID-28065)
Solar neutrinos and the role of exchange currents in the pp reaction, 3:27233
PROTON-PROTON INTERACTIONS/INCLUSIVE INTERACTIONS
Analysis of weak-interaction effects in high-transverse-momentum hadron-hadron collisions (Parton model, p violation, cross sections, effective gluon model), 3:27196
Recent developments in the theory of large transverse momentum processes, 3:27119 (SLAC-PUB-1806)
PROTON-PROTON INTERACTIONS/MULTIPLE PRODUCTION
Growth of the average multiplicity with increasing transverse momentum, 3:27238
Parton-picture unitary impact-parameter model for multicluster production, 3:27229
PROTON-PROTON INTERACTIONS/PSI RESONANCES
Psi production and high-mass electron-pair limit in pp collisions at square-roots=52 GeV, 3:27133
PROTON-PROTON INTERACTIONS/SCATTERING AMPLITUDES
Analysis of weak-interaction effects in high-transverse-momentum hadron-hadron collisions (Parton model, p violation, cross sections, effective gluon model), 3:27196
PROTON-PROTON INTERACTIONS/WEAK INTERACTIONS
Analysis of weak-interaction effects in high-transverse-momentum hadron-hadron collisions (Parton model, p violation, cross sections, effective gluon model), 3:27196
PROTOPLASTS
See PLANT CELLS
PROTOZOA
See also BABESIDAE
PROTOZOA/ELECTRON MICROSCOPY
Proceedings of the 14th annual electron microscopy colloquium, 3:26952 (CONF-770504-)
PROTOZOA/INFECTIVITY
Myopathy associated with a murine Sarcocystic infection, 3:26982 (CONF-770504-)
PROTOZOA/LIFE CYCLE
Ultrastructure of cryptosporidia in the Bovine species, 3:26975 (CONF-770504-)
PROTOZOA/ULTRASTRUCTURAL CHANGES
Ultrastructure of cryptosporidia in the Bovine species, 3:26975 (CONF-770504-)
PSEUDOSCALAR MESONS
(Mesons with spin-parity of zero-minus.)
See also ETA MESONS
ETA-958 RESONANCES
KAONS
PIONS
PSEUDOSCALAR MESONS/CONFIGURATION MIXING
Simple symmetry breaking in a chiral SU(4) x SU(4) model of pseudoscalar mesons, 3:27199

PSEUDOSCALAR MESONS/DECAY
Simple symmetry breaking in a chiral SU(4) x SU(4) model of pseudoscalar mesons, 3:27199
PSEUDOSCALAR MESONS/LEPTONIC DECAY
Charmed-meson decay in the massive-quark model, 3:27192
PSEUDOSCALAR MESONS/MASS SPECTRA
Simple symmetry breaking in a chiral SU(4) x SU(4) model of pseudoscalar mesons, 3:27199
PSI RESONANCES/DECAY
Influence of hadronic decay channels in confinement models of the new resonances (Confinement models, coupling), 3:27222
Production of new particles and muon-electron events in e^+-e^- annihilation at spear, 3:27100 (SLAC-PUB-1737)
PSI RESONANCES/GLUON MODEL
Gauge fields and strong interactions (Lectures), 3:27212
PSI RESONANCES/PARTICLE PRODUCTION
Psi production and high-mass electron-pair limit in pp collisions at square-roots=52 GeV, 3:27133
Study of final states in $\pi^- N \rightarrow \mu^+ \mu^-$ + hadrons at 225 GeV (Cross sections), 3:27144
PSI RESONANCES/PARTICLE PROPERTIES
Production of new particles and muon-electron events in e^+-e^- annihilation at spear, 3:27100 (SLAC-PUB-1737)
Recent results on new particle production at SPEAR (Tau, π, mixing, mass, production cross sections), 3:27137 (SLAC-PUB-1998)
PSI RESONANCES/PHOTOPRODUCTION
Photoproduction of J/psi mesons in the peripheral model. The direct peripheral mechanism, 3:27181
psi and excess leptons in photoproduction (A dependence, cross sections, preliminary report), 3:27099 (SLAC-PUB-1728)
PSI-3105 RESONANCES/DECAY
$e^+ e^-$ interactions (Total cross sections, lecture, review, scale invariance), 3:27170 (SLAC-PUB-1643)
Phenomenology of electron positron annihilation into hadrons (Total cross sections, quarks, color), 3:27183
PSI-3105 RESONANCES/PARTICLE PROPERTIES
$e^+ e^-$ interactions (Total cross sections, lecture, review, scale invariance), 3:27170 (SLAC-PUB-1643)
PSI-3695 RESONANCES/DECAY
$e^+ e^-$ interactions (Total cross sections, lecture, review, scale invariance), 3:27170 (SLAC-PUB-1643)
Phenomenology of electron positron annihilation into hadrons (Total cross sections, quarks, color), 3:27183
PSI-3695 RESONANCES/PARTICLE PROPERTIES
$e^+ e^-$ interactions (Total cross sections, lecture, review, scale invariance), 3:27170 (SLAC-PUB-1643)
PULSATOR STELLARATOR/ELECTRIC DISCHARGES
Statistical distribution of high density discharges in the Pulsator Tokamak, 3:27491 (IPP-III/35)
PULSED FUSION REACTORS/PLASMA DIAGNOSTICS
Direct measurement of compression of laser-imploded targets using x-ray spectroscopy, 3:27474
PULSED MHD GENERATORS/ENERGY YIELD
Limiting values of the energy generated by pulsed MHD converters, 3:26536
PUMPED STORAGE POWER PLANTS/MATHEMATICAL MODELS
Marysville Lake hydrothermal study. Report 1. 900-mW project; hydraulic and mathematical model investigation. Technical report, August 1975-October 1976, 3:26481 (AD-A-042556)
PUMPS/DESIGN
Reactor coolant pump for a nuclear reactor (Patent), 3:26376
PUMPS/MATERIALS TESTING
Evaluation of materials for use in letdown valves and coal feed pumps for coal liquefaction service. Final report, 3:25647 (EPRI-AF-579)
PWR TYPE REACTORS
See also CALHOUN-1 REACTOR
CALHOUN-2 REACTOR
CE STANDARD REACTOR
CHEROKEE-1 REACTOR
CHEROKEE-2 REACTOR
CHEROKEE-3 REACTOR
GREIFSWALD-2 REACTOR
LOFT REACTOR
MUELHEIM-KAERLICH REACTOR
PAKS-1 REACTOR
PERKINS-1 REACTOR
PERKINS-2 REACTOR
PERKINS-3 REACTOR
WWER TYPE REACTORS
ZARNOWIEC REACTOR
Energy from nuclear reactors. Water as moderator: LWR reactors prevail. Pt. 1, 3:26219
Energy from nuclear reactors. Pt. 2. The functioning of nuclear power plants with PWR reactors, 3:26244
PWR TYPE REACTORS/BLOWDOWN
Computer code for nuclear reactor core thermal transients, 3:26446
PWR Blowdown Heat Transfer Separate-Effects Program. Thermal-Hydraulic Test Facility experimental data report for test 105, 3:26440 (ORNL/NUREG/TM-143)
PWR TYPE REACTORS/CONSTRUCTION
Nuclear power plants. Construction status report, data as of December 31, 1977 (USA), 3:26210 (NUREG-0030-78/01)
PWR TYPE REACTORS/CONTAINMENT BUILDINGS
Containment for small pressurized water reactors, 3:26227 (CONF-771109-90)
Reactor building for a nuclear reactor (Patent), 3:26479
PWR TYPE REACTORS/FEEDWATER HEATERS
Feed water pre-heater with two steam spaces (Patent), 3:26224
PWR TYPE REACTORS/FUEL MANAGEMENT
Optimal power profile fuel management, 3:26250
PWR TYPE REACTORS/FUEL PARTICLES
Properties and irradiation behavior of advanced oxide particle fuel, 3:26305
PWR TYPE REACTORS/FUEL RODS
Response of unirradiated and irradiated PWR fuel rods tested under power-cooling-mismatch conditions, 3:26443 (TREE-NUREG-1196)
PWR TYPE REACTORS/FUEL-CLADDING INTERACTIONS
Chemical thermodynamics of the system Cs-U-Zr-H-I-O in the LWR fuel-clad gap, 3:26211 (ORNL/TM-6130)
PWR TYPE REACTORS/LOSS OF COOLANT
TECAR, a new program for LOCA analysis, 3:26448
PWR TYPE REACTORS/POWER-COOLING-MISMATCH ACCIDENTS
Response of unirradiated and irradiated PWR fuel rods tested under power-cooling-mismatch conditions, 3:26443 (TREE-NUREG-1196)
PWR TYPE REACTORS/PRESSURE VESSELS
Novel design for PWR pressure vessels, 3:26238
Nuclear reactor (Patent), 3:26225
Ultrasonic inspection of the spherically shaped perforated areas of light water reactor pressure vessels, 3:26214
PWR TYPE REACTORS/PRIMARY COOLANT CIRCUITS
Plant engineering experience with primary water purification plants in nuclear power stations with pressurised and boiling water reactors, 3:26216
PWR TYPE REACTORS/REACTOR COOLING SYSTEMS
Nuclear facilities. Recurrent inspections. Mechanical ultrasonic inspection. Draft, 3:26215
PWR TYPE REACTORS/REACTOR KINETICS
Changes in pressurized water reactor group constants caused by burnup and the role of fuel nuclides, 3:26247
PWR TYPE REACTORS/REACTOR NOISE
Studies on space dependence of the spectral density functions of neutron flux noise in pressurized water reactors, 3:26230
PWR TYPE REACTORS/REACTOR OPERATION
Licensed operating reactors. Operating units status report, data as of 12-31-77 (USA), 3:26209 (NUREG-0020(Vol.2)(No.1))
PWR TYPE REACTORS/REACTOR PROTECTION SYSTEMS
Environmental qualification of safety-related Class 1E process instrumentation, 3:26445 (WCAP-9211)
PWR TYPE REACTORS/REACTOR SAFETY
Safety no obstacle to a British PWR, 3:26458
PWR TYPE REACTORS/SECONDARY COOLANT CIRCUITS
Back pressure: tight main steam isolating valves for PWRs, 3:26234
PWR TYPE REACTORS/STANDARDIZATION
Irreversible process for Framatome, 3:26239
KWU puts the emphasis on planning and control, 3:26237
Progress report on the SNUPPS nuclear stations, 3:26240
PWR TYPE REACTORS/STEAM GENERATORS
Boiler (Patent), 3:26246
Burst protection for containers under high pressure, in particular steam generators (Patent), 3:26252
PWR TYPE REACTORS/STEAM LINES
Pressurized-water reactor (Patent), 3:26253
PWR TYPE REACTORS/ULTRASONIC TESTING
Nuclear facilities. Recurrent inspections. Mechanical ultrasonic inspection. Draft, 3:26215
PWR-41 TYPE REACTORS
See WESTINGHOUSE STANDARD REACTOR
PWR-80 TYPE REACTORS
See CE STANDARD REACTOR
PYRIDINE/CATALYTIC EFFECTS
Homogeneous catalytic hydrocracking processes for conversion of coal to liquid fuels: basic and exploratory research. Quarterly report No. 7, May 1, 1977-July 31, 1977, 3:25653 (FE-2202-21)
PYRIDINE/CHEMICAL REACTIONS
Homogeneous catalytic hydrocracking processes for conversion of coal to liquid fuels: basic and exploratory research. Quarterly report No. 7, May 1, 1977-July 31, 1977, 3:25653 (FE-2202-21)

PYRITE/CATALYTIC EFFECTS
Effects of mineral matter on the hydroliquefaction of coal, 3:25663 (SAND-77-1558C)
PYROLYSIS/BY-PRODUCTS
Synthetic methods of using secondary pyrolysis by-products, 3:25792
PYRRHOTITE/CATALYTIC EFFECTS
Effects of mineral matter on the hydroliquefaction of coal, 3:25663 (SAND-77-1558C)

Q

QUANTITATIVE CHEMICAL ANALYSIS/QUALITY ASSURANCE
Laboratory quality assurance and its role in nuclear fuel reprocessing and refabrication, 3:26661 (HEDL-SA-1258)
QUANTITATIVE CHEMICAL ANALYSIS/SENSITIVITY
Selective single atom detection in a 10^{19} atom background, 3:27062
QUANTUM CHROMODYNAMICS/CHARM PARTICLES
Quantum chromodynamics predictions for the associated production of charm by neutrinos, 3:27186
QUANTUM CHROMODYNAMICS/CHIRALITY
Chiral properties of the fermionic determinant in quantum chromodynamics, 3:27245
QUANTUM CHROMODYNAMICS/GREEN FUNCTION
Near-mass-shell infrared behavior of non-Abelian gauge theories and the renormalization group, 3:27279
QUANTUM CHROMODYNAMICS/INFRARED DIVERGENCES
Calculations of the infrared behavior of quantum chromodynamics: The color-singlet quark form factor in the near-mass-shell regime, 3:27280
QUANTUM CHROMODYNAMICS/MUON-PROTON INTERACTIONS
Clean tests of quantum chromodynamics in μp scattering, 3:27172
QUANTUM CHROMODYNAMICS/RENORMALIZATION
Near-mass-shell infrared behavior of non-Abelian gauge theories and the renormalization group, 3:27279
QUANTUM ELECTRODYNAMICS/CONSERVATION LAWS
Charge conservation and gauge invariance, 3:27303
QUANTUM ELECTRODYNAMICS/DIMENSIONS
Gauge theories: an introduction (Review lectures, V-A theory, intermediate vector boson model), 3:27295
QUANTUM ELECTRODYNAMICS/GAUGE INVARIANCE
Charge conservation and gauge invariance, 3:27303
Gauge theories: an introduction (Review lectures, V-A theory, intermediate vector boson model), 3:27295
QUANTUM ELECTRODYNAMICS/POINCARE GROUPS
Free field theories of spin-mass trajectories and quantum electrodynamics in the null plane, 3:27241
QUANTUM ELECTRODYNAMICS/PROPAGATOR
Charge conservation and gauge invariance, 3:27303
QUANTUM ELECTRODYNAMICS/RADIATIVE CORRECTIONS
Status of the analytic calculations of QED sixth order radiative corrections to the electron anomaly, 3:27294
QUANTUM ELECTRODYNAMICS/REGGE TRAJECTORIES
Free field theories of spin-mass trajectories and quantum electrodynamics in the null plane, 3:27241
QUANTUM ELECTRODYNAMICS/REVIEWS
Aspects of QED, 3:27293
Impact of quantum electrodynamics, 3:27255 (SLAC-PUB-1699)
QUANTUM ELECTRODYNAMICS/SYMMETRY BREAKING
Gauge theories: an introduction (Review lectures, V-A theory, intermediate vector boson model), 3:27295
QUANTUM FIELD THEORY
See also LAGRANGIAN FIELD THEORY
QUANTUM ELECTRODYNAMICS
Alternative approach to constructive lambdaPHI$_4^4$ quantum field theory (Construction of interacting quantum scalar fields for four-dimensional space-time), 3:27308
Bound states, critical points, and recent results in quantum field models, 3:27302
Constructive approach to nonlinear quantum field theory, 3:27307
Euclidean quantum field theory, 3:27301
Value and the scope of quantum field theory, 3:27299
QUANTUM FIELD THEORY/BOUNDARY CONDITIONS
Asymptotic behavior in quantum field theory, 3:27298
Violations of dimensional analysis in renormalized perturbation theory, 3:27282
QUANTUM FIELD THEORY/CLUSTER EXPANSION
Cluster expansions and their application to the n-particle structure of weakly coupled quantum field models, 3:27300
QUANTUM FIELD THEORY/CONFORMAL INVARIANCE
Conformal invariance of quantum fields in two-dimensional space-time, 3:27304
QUANTUM FIELD THEORY/DISTANCE
Asymptotic behavior in quantum field theory, 3:27298
QUANTUM FIELD THEORY/GAUGE INVARIANCE
Gauge fixing and mass renormalization in the lattice gauge theory, 3:27281
QUANTUM FIELD THEORY/GREEN FUNCTION
Conformal expansion for Euclidean Green functions (Self-interacting scalar field in even number of space-time dimensions), 3:27305
Violations of dimensional analysis in renormalized perturbation theory, 3:27282
QUANTUM FIELD THEORY/HADRONS
Hadrons (usual and newly discovered) in gauge theories a dream, 3:27213
QUANTUM FIELD THEORY/INSTANTONS
Instantons and spin forces between massive quarks, 3:27256
QUANTUM FIELD THEORY/KINETIC ENERGY
Kinetic-energy considerations and the vacuum, 3:27283
QUANTUM FIELD THEORY/LIGHT CONE
Demise of light cone field theory, 3:27291
QUANTUM FIELD THEORY/MASS RENORMALIZATION
Gauge fixing and mass renormalization in the lattice gauge theory, 3:27281
QUANTUM FIELD THEORY/MEETINGS
Weak and electromagnetic interactions at high energies. Part A, 3:27292
QUANTUM FIELD THEORY/PERTURBATION THEORY
Path integral formulation of mean-field perturbation theory, 3:27272
QUANTUM FIELD THEORY/QUARKS
Quark confinement and field theory, 3:27160
QUANTUM FIELD THEORY/RENORMALIZATION
Asymptotic behavior in quantum field theory, 3:27298
Collective phenomena and renormalization of nonlinear spinor theories (Nambu-Jona-Lasino model, perturbation series), 3:27288
Renormalization of gauge fields models (Lectures, regularization, independence, SU(2), Higgs-Kibble model, action principle), 3:27296
QUANTUM FIELD THEORY/SPINORS
Recent developments in nonlinear spinor theories (Subcanonical fields with dimension $\frac{1}{2}$), 3:27306
QUANTUM FIELD THEORY/STATISTICAL MECHANICS
Statistical mechanics of a $(1 + 1)$-dimensional quantum field theory at finite density and temperature, 3:27276
QUANTUM FIELD THEORY/STRONG-COUPLING MODEL
Particle limit of field theory: A new strong-coupling expansion, 3:27275
QUANTUM FIELD THEORY/SYMMETRY
Supersymmetry, 3:27297
QUANTUM FIELD THEORY/SYMMETRY BREAKING
Possible supersymmetry breaking by pseudoparticles, 3:27244
Super-Higgs effect in a new class of scalar models and a model of super QED, 3:27257
QUANTUM FIELD THEORY/TOPOLOGY
Kinetic-energy considerations and the vacuum, 3:27283
QUANTUM MECHANICS
Category of the CROCs and their interpretation (Canonically Relatively Orthocomplemented ensembles), 3:27412
Symmetries gained and lost, 3:27424
QUANTUM MECHANICS/LIPPMANN-SCHWINGER EQUATION
Problem of several delta-shell potentials in the Lippmann-Schwinger formulation, 3:27407
QUANTUM MECHANICS/MATHEMATICAL MANIFOLDS
Geometric quantization of symplectic manifolds, 3:27423
QUANTUM MECHANICS/SCHROEDINGER EQUATION
Positivity of an integral connected with the helium atom problem, 3:27408
QUANTUM MECHANICS/VECTORS
Theory of analytic vectors and applications (Algebra of observables), 3:27410
QUANTUM OPERATORS/KERNELS
Geometric quantization: an extended procedure, 3:27411
QUARK CONFINEMENT
See BAG MODEL
QUARK MODEL/BOUND STATE
Interpretation of the Y (9.5) as evidence for another quark, 3:27185
QUARK MODEL/CHARM PARTICLES
Charmed-meson decay in the massive-quark model, 3:27192
QUARK MODEL/CONFIGURATION MIXING
etaeta' and ωphi mixing in the nonrelativistic quark model, 3:27179
QUARK MODEL/CONFINEMENT
Comments on a paper by Callan, Coote, and Gross (Quark binding), 3:27265

Generalization of the quark-confining string, 3:27157
QUARK MODEL/CP INVARIANCE
Conditions for natural suppression of CP violation, 3:27251
QUARK MODEL/ELECTROPRODUCTION
Electroproduction of inclusive pions at high Q^2 (Cross sections, feynmon scaling), 3:27104
QUARK MODEL/HEAVY LEPTONS
Neutral heavy leptons and e^+e^- colliding-beam experiments, 3:27193
QUARK MODEL/MASS FORMULAE
Interpretation of the Y (9.5) as evidence for another quark, 3:27185
QUARK MODEL/NEUTRAL CURRENTS
Gauge theories of weak interactions with left-right symmetry and the structure of neutral currents, 3:27250
QUARK MODEL/OKUBO MASS FORMULA
Consequences of quark-line (Okubo-Zweig-Iizuka) rule, 3:27218
QUARK MODEL/PARTICLE MULTIPLETS
Does the baryon spectrum reveal a diquark structure, 3:27225
QUARK MODEL/POSTULATED PARTICLES
New absolutely stable hadrons, 3:27149
QUARK MODEL/PSI RESONANCES
Gauge fields and strong interactions (Lectures), 3:27212
QUARK MODEL/QUANTUM NUMBERS
Retention of quantum numbers by quark and multiquark jets, 3:27159
QUARK MODEL/RESONANCE PARTICLES
Hydrodynamic model of collective resonances in hadronic matter, 3:27220
QUARK MODEL/SCALE INVARIANCE
Distinguishing scaling violations from new currents, 3:27194
QUARK MODEL/SYMMETRY BREAKING
Internal symmetries and ghost symmetries, 3:27246
QUARK MODEL/WAVE EQUATIONS
Solutions to a gauge-invariant, equal-time two-body wave equation. Light-mass quark-antiquark system, 3:27154
QUARK MODEL/WEAK NEUTRAL CURRENTS
Flavor conservation in an SU(3) x U(1) x U(1) model, 3:27198
QUARKS/BINDING ENERGY
Is there a signal of quark confinement from perturbation theory, 3:27161
QUARKS/BOUND STATE
Gauge fields and strong interactions (Lectures), 3:27212
Newly found resonance Y (9.5) and the charge of the heavy quark, 3:27148
QUARKS/CONFINEMENT
Is there a signal of quark confinement from perturbation theory, 3:27161
Near-mass-shell infrared behavior of non-Abelian gauge theories and the renormalization group, 3:27279
Quark confinement and field theory, 3:27160
Quark confinement (Lectures), 3:27206 (SLAC-PUB-2020)
QUARKS/COUPLING
More freedom now: an explanation of local duality and other mysteries, 3:27164
QUARKS/ELECTRIC CHARGES
Newly found resonance Y (9.5) and the charge of the heavy quark, 3:27148
QUARKS/ELECTROMAGNETIC INTERACTIONS
Quark-quark interactions at the p anti p Collider, 3:27207 (TID-28062)
QUARKS/FORM FACTORS
Calculations of the infrared behavior of quantum chromodynamics: The color-singlet quark form factor in the near-mass-shell regime, 3:27280
QUARKS/J-J COUPLING
Instantons and spin forces between massive quarks, 3:27256
QUARKS/MASS SPECTRA
Three generations of quarks and leptons (Review, Weinberg-Salam gauge model, Higgs particles), 3:27240 (SLAC-PUB-1974)
QUARKS/MEETINGS
Quark confinement and field theory, 3:27160
QUARKS/PARTICLE INTERACTIONS
Is there a signal of quark confinement from perturbation theory, 3:27161
Recent developments in the theory of large transverse momentum processes, 3:27119 (SLAC-PUB-1806)
Three generations of quarks and leptons (Review, Weinberg-Salam gauge model, Higgs particles), 3:27240 (SLAC-PUB-1974)
QUARKS/PARTICLE PRODUCTION
Search for heavy particles, 3:27184 (SLAC-PUB-1891)
QUARKS/QUANTUM NUMBERS
Retention of quantum numbers by quark and multiquark jets, 3:27159
QUARKS/REVIEWS
Quarks, 3:27165
QUARKS/STRONG INTERACTIONS
Quark-quark interactions at the p anti p Collider, 3:27207 (TID-28062)
QUARKS/WEAK INTERACTIONS
Three generations of quarks and leptons (Review, Weinberg-Salam gauge model, Higgs particles), 3:27240 (SLAC-PUB-1974)
QUASARS/EMISSION SPECTRA
Fluctuations of quasars and other astronomical sources: final report on New Research Initiatives Program W-210 (Cosmological distance, luminosity), 3:27024 (LA-7092-MS)
QUASARS/RED SHIFT
Fluctuations of quasars and other astronomical sources: final report on New Research Initiatives Program W-210 (Cosmological distance, luminosity), 3:27024 (LA-7092-MS)
QUASARS/VARIATIONS
Fluctuations of quasars and other astronomical sources: final report on New Research Initiatives Program W-210 (Cosmological distance, luminosity), 3:27024 (LA-7092-MS)
QUINONES/REDOX REACTIONS
Annual progress report, September 1, 1976-November 30, 1977 (Chromophores in photosynthetic membranes and reaction centers of Rhodopseudomonas sp.), 3:26945 (COO-3162-36)

R

RADIATION ACCIDENTS/THERMOLUMINESCENT DOSIMETRY
Hanford critical radiation dosimeter, 3:26826 (PNL-2276)
RADIATION DOSE DISTRIBUTIONS/DATA COMPILATION
Standardized radioactive decay data sets for use in radiation dosimetry, 3:26991 (IAEA-SM-222/51)
RADIATION DOSES/COMPUTER CALCULATIONS
Jeremiah environmental computational system (Monitoring radioactive effluents from nuclear fuel cycle), 3:26887 (DP-MS-77-41)
RADIATION DOSIMETRY
See DOSIMETRY
RADIATION EXPOSURE (DOSES)
See RADIATION DOSES
RADIATION MONITORING
See also PERSONNEL MONITORING
Validity and design of environmental surveillance systems for operating nuclear power plants. Final report, 3:26412 (EPRI-NP-604)
RADICALS
See also HYDROXYL RADICALS
RADICALS/**ELECTRON SPIN RESONANCE**
Development of methods for determining organic free radical structures by electron spin resonance and application to the radiation chemistry of nucleic acid model compounds (X radiation), 3:26694 (UR/3490/LCP-6)
RADIOACTIVE AEROSOLS/ALPHA DOSIMETRY
Integrated minicomputer alpha analysis system (Measurements of alpha activities of particulates), 3:26888 (LA-UR-77-2968)
RADIOACTIVE AEROSOLS/**RADIOACTIVITY TRANSPORT**
Breeder Reactor Aerosol Release and Transport Program. Quarterly progress report, April-June 1977, 3:26439 (ORNL/NUREG/TM-142)
RADIOACTIVE BIOLOGICAL WASTES
See RADIOACTIVE WASTES
RADIOACTIVE EFFLUENTS
See also RADIOACTIVE WASTES
RADIOACTIVE EFFLUENTS/**ENVIRONMENTAL TRANSPORT**
Environmental report No. 22, January-June 1977, 3:26889 (NP-22643)
Jeremiah environmental computational system (Monitoring radioactive effluents from nuclear fuel cycle), 3:26887 (DP-MS-77-41)
Population dose commitments due to radioactive releases from nuclear power plant sites in 1975, 3:26992 (PNL-2439)
RADIOACTIVE EFFLUENTS/**HEALTH HAZARDS**
Environmental assessment methodology for the nuclear fuel cycle, 3:26873 (BNWL-2219)
RADIOACTIVE EFFLUENTS/**TRANSPORT**
Plant for decanting strongly radioactive resins in waste containers (Patent), 3:25924
RADIOACTIVE MATERIALS/TRANSPORT
Statistical analysis of low-radiation packages in the transport of radioactive material, 3:25923
RADIOACTIVE WASTE DISPOSAL
See also SHAFT EXCAVATIONS

RADIOACTIVE WASTE DISPOSAL/BIBLIOGRAPHIES
Shallow land burial of low-level radioactive wastes (129 abstracted references), 3:25938 (ORNL/EIS-115)
RADIOACTIVE WASTE DISPOSAL/CONTAINERS
Compatibility testing of vitrified waste forms, 3:25936 (DP-MS-77-115)
RADIOACTIVE WASTE DISPOSAL/PUBLIC OPINION
Public values associated with nuclear waste disposal (Results of a questionnaire sent to 465 study participants), 3:25935 (BNWL-1997)
RADIOACTIVE WASTE DISPOSAL/RADIATION HAZARDS
Hazard associated with vitrified high-level radioactive waste, 3:25941
RADIOACTIVE WASTE DISPOSAL/UNDERGROUND DISPOSAL
Preliminary environmental assessments of disposal of rock mined during excavation of a federal repository for radioactive waste, 3:25939 (Y/OWI/SUB-77/42503)
Shallow land burial of low-level radioactive wastes (129 abstracted references), 3:25938 (ORNL/EIS-115)
RADIOACTIVE WASTE MANAGEMENT
See also RADIOACTIVE WASTE STORAGE
RADIOACTIVE WASTE MANAGEMENT/ENVIRONMENTAL EFFECTS
Applications to waste management operations (Terrestrial ecosystems), 3:25951 (PNL-2253)
Impact of radioactive waste management operations, 3:25949 (PNL-2253)
RADIOACTIVE WASTE MANAGEMENT/ENVIRONMENTAL IMPACTS
Considerations of environmental protection criteria for radioactive waste. Background report, 3:25926 (NP-23021)
RADIOACTIVE WASTE MANAGEMENT/INVENTORIES
Ecology of Hanford 200 Area and 1976 radionuclide inventory, 3:25944 (PNL-2253)
RADIOACTIVE WASTE MANAGEMENT/RISK ASSESSMENT
Considerations of environmental protection criteria for radioactive waste. Background report, 3:25926 (NP-23021)
RADIOACTIVE WASTE PROCESSING/COMBUSTION
Procedure for purifying a filter column (Patent), 3:25929
RADIOACTIVE WASTE PROCESSING/EVAPORATION
Concentration of aqueous radioactive waste with wiped-film evaporators, 3:25934
Evolution of radwaste evaporators in West Germany, 3:25932
RADIOACTIVE WASTE PROCESSING/FLOCCULATION
Improvement on removal of radio-cobalt from waste water by ferric hydroxide coagulation-flocculation process using diethyldithiocarbamate, 3:25931
RADIOACTIVE WASTE PROCESSING/SOLIDIFICATION
Conceptual process for conversion of high level waste to glass, 3:25928 (DPST-75-426-TL)
Techniques for the solidification of high-level wastes, 3:25930
RADIOACTIVE WASTE STORAGE/GEOLOGIC DEPOSITS
Appraisal of hard rock for potential underground repositories of radioactive wastes, 3:25937 (LBL-7004)
RADIOACTIVE WASTE STORAGE/SOLID WASTES
Leaching behavior of strontium-90 in cement composites, 3:25942
RADIOACTIVE WASTE STORAGE/UNDERGROUND STORAGE
Appraisal of hard rock for potential underground repositories of radioactive wastes, 3:25937 (LBL-7004)
RADIOACTIVE WASTES
See also RADIOACTIVE EFFLUENTS
RADIOACTIVE WASTES/COMPATIBILITY
Compatibility testing of vitrified waste forms, 3:25936 (DP-MS-77-115)
RADIOACTIVE WASTES/DATA ANALYSIS
Detailed accident analysis for the high level waste preparation phase of the commercial nuclear waste vitrification project, 3:26989 (BNWL-2207)
RADIOACTIVE WASTES/ENVIRONMENTAL EFFECTS
Detailed accident analysis for the high level waste preparation phase of the commercial nuclear waste vitrification project, 3:26989 (BNWL-2207)
RADIOACTIVE WASTES/VITRIFICATION
Detailed accident analysis for the high level waste preparation phase of the commercial nuclear waste vitrification project, 3:26989 (BNWL-2207)
RADIOCARBON DATING
See CARBON 14
RADIOISOTOPE MIGRATION
See RADIONUCLIDE MIGRATION
RADIOISOTOPES/DECAY
Standardized radioactive decay data sets for use in radiation dosimetry, 3:26991 (IAEA-SM-222/51)
RADIOISOTOPES/ENVIRONMENTAL EFFECTS
Radionuclides in air, water, and biota (^{40}K, ^{7}Be, ^{137}Cs), 3:26934 (TID-26712)
RADIOISOTOPES/FILTRATION
Decontamination of water containing chemical and radiological warfare agents by reverse osmosis. Technical report Jul-Nov 76, 3:26933 (AD-A-046203)
RADIOISOTOPES/RADIATION DOSE DISTRIBUTIONS
Standardized radioactive decay data sets for use in radiation dosimetry, 3:26991 (IAEA-SM-222/51)
RADIOMETERS/DESIGN
Precision insolation measurement under field conditions, 3:25984
RADIONUCLIDE MIGRATION
(In environment.)
RADIONUCLIDE MIGRATION/DATA COMPILATION
Initial synthesis of area 13 ^{239}Pu data and other statistical analyses (^{239}Pu and ^{240}Pu distribution in soil and biological samples from Nevada Test Site), 3:26912 (NVO-171)
RADIONUCLIDE MIGRATION/MATHEMATICAL MODELS
Management models (Terrestrial ecosystems), 3:25950 (PNL-2253)
RADIONUCLIDES
See RADIOISOTOPES
RADIOPHARMACEUTICALS/CHEMICAL PREPARATION
Biomedical research and application utilizing cyclotron produced radionuclides. Progress report, January 1 1977-December 31, 1977, 3:26971 (COO/4268-1)
RADIOPHARMACEUTICALS/COMPARATIVE EVALUATIONS
Tumor scanning agents, 3:26973
RADIOPHARMACEUTICALS/TISSUE DISTRIBUTION
Bone-seeking radionuclides: an in vivo study of factors affecting skeletal uptake, 3:26972
RADIOSURGERY
See RADIOTHERAPY
RADIOTHERAPY/BIOCHEMICAL REACTION KINETICS
Radiation effects on cells and chromosomes (A bibliography with abstracts). Report for 1964-August 1977, 3:26988 (NTIS/PS-77/0753)
RARE EARTHS
See also GADOLINIUM
RARE EARTHS/ABUNDANCE
Rare earth and other trace elements in historic Azorean lavas, 3:27009
RARE EARTHS/ION EXCHANGE
Cation exchange of 53 elements in nitric acid, 3:26665 (LA-7083)
RATS/ENVIRONMENTAL EFFECTS
Status of the Norway rat, 3:26904 (TID-26712)
RATS/POPULATION DENSITY
Status of the Norway rat, 3:26904 (TID-26712)
RAYLEIGH-TAYLOR INSTABILITY/INSTABILITY GROWTH RATES
Low frequency instability of liquid liner implosions driven by multiple free pistons. Memorandum report, 3:27536 (AD-A-043284)
RDF
See REFUSE DERIVED FUELS
REACTOR ACCIDENTS
See also EXCURSIONS
FUEL ELEMENT FAILURE
LOSS OF COOLANT
LOSS OF FLOW
MELTDOWN
POWER-COOLING-MISMATCH ACCIDENTS
REACTOR CORE DISRUPTION
REACTOR ACCIDENTS/BIOLOGICAL RADIATION EFFECTS
Competing risk model for reduction in life expectancy from radiogenic latent cancer (Radiation exposure as result of nuclear reactor accidents), 3:26985 (SAND-77-1352C)
REACTOR CHARGING MACHINES/DESIGN
Turnstile device for fuel unloading of nuclear reactors (Patent; LMFBR), 3:26288 (ANL-Trans-1112)
REACTOR COMPONENTS
See also BREEDING BLANKETS
CONTROL ELEMENTS
CONTROL ROD DRIVES
FUEL ELEMENTS
REACTOR CHARGING MACHINES
REACTOR COOLING SYSTEMS
REACTOR CORES
REACTOR COMPONENTS/DECONTAMINATION
Sodium technology and cover gas seal development programs. Quarterly technical progress report, July-September 1977 (LMFBR), 3:26274 (AI-DOE-13208)
REACTOR COMPONENTS/RELIABILITY
Modelling the time dependent nature of structural reliability, 3:26357 (GEFR-SP-050)
Unavailability and failure intensity of components, 3:26362
REACTOR COMPONENTS/STRESS ANALYSIS
Modelling the time dependent nature of structural reliability, 3:26357 (GEFR-SP-050)

REACTOR CONTROL RODS
See CONTROL ELEMENTS
REACTOR CONTROL SYSTEMS
(The processes and operations ensuring the control and safe running of a nuclear reactor.)
Experiments in connection with control of boron acid concentration by ion exchange in Hungary, 3:26408
REACTOR CONTROL THEORY
See REACTOR KINETICS
REACTOR COOLING SYSTEMS
See also PRIMARY COOLANT CIRCUITS
SECONDARY COOLANT CIRCUITS
REACTOR COOLING SYSTEMS/ACOUSTIC MONITORING
Application of acoustic emission techniques to integrity assessment of nuclear reactor components, 3:26371
Ultrasonic wave generator (Patent), 3:26377
REACTOR COOLING SYSTEMS/DECONTAMINATION
Method for removing radioactive corrosion products from the inner surfaces of a nuclear reactor (Patent), 3:26378
REACTOR COOLING SYSTEMS/FAILURES
Structural integrity of water reactor pressure boundary components. Progress report for period ending 28 February 1977, 3:26430 (AD-A-042219)
REACTOR COOLING SYSTEMS/LEAK TESTING
Sodium-to-gas leak detection. Annual technical progress report, government fiscal year 1977 (LMFBR), 3:26275 (AI-DOE-13211)
REACTOR COOLING SYSTEMS/NUCLEATE BOILING
Dynamics of nucleate region flow boiling, 3:26348
REACTOR COOLING SYSTEMS/PIPES
Evaluations of the piping system inelastic analysis computer program PIRAX2 (LMFBR), 3:26276 (AI-DOE-13216)
REACTOR COOLING SYSTEMS/PUMPS
Reactor coolant pump for a nuclear reactor (Patent), 3:26376
REACTOR COOLING SYSTEMS/RADIATION MONITORING
Radioanalysis of water circuit at nuclear power plants, 3:26249
REACTOR COOLING SYSTEMS/SEALS
Sodium technology and cover gas seal development programs. Quarterly technical progress report, July-September 1977 (LMFBR), 3:26274 (AI-DOE-13208)
REACTOR COOLING SYSTEMS/STEAM SEPARATORS
Vapor separator for a nuclear reactor plant (Patent), 3:26372
REACTOR COOLING SYSTEMS/ULTRASONIC TESTING
Nuclear facilities. Recurrent inspections. Mechanical ultrasonic inspection. Draft, 3:26215
REACTOR COOLING SYSTEMS/VALVES
Countermeasures to prevent leakage from valve stem area, 3:26370
REACTOR COOLING SYSTEMS/WATER CHEMISTRY
Method for removing radioactive corrosion products from the inner surfaces of a nuclear reactor (Patent), 3:26378
REACTOR CORE DISRUPTION
Advanced fuels safety comparisons (LMFBR), 3:26477
REACTOR CORE DISRUPTION/FISSION PRODUCT RELEASE
Breeder Reactor Aerosol Release and Transport Program. Quarterly progress report, April-June 1977, 3:26439 (ORNL/NUREG/TM-142)
REACTOR CORE DISRUPTION/HEAT TRANSFER
Analysis of core disruptive accidents in carbide-fueled LMFBRs, 3:26475
REACTOR CORE DISRUPTION/REACTIVITY WORTHS
Analysis of core disruptive accidents in carbide-fueled LMFBRs, 3:26475
REACTOR CORE RESTRAINTS/DESIGN
Device for supporting the core of a fast neutron reactor (Patent), 3:26286 (ANL-Trans-1114)
REACTOR CORES
See also COUPLED REACTOR CORES
Reactor core consisting of a number of interspersed groups of identical columns (Patent), 3:26266
REACTOR CORES/HOT SPOTS
Hot spots in active packed beds, 3:26257
REACTOR CORES/SEISMIC EFFECTS
Status of the General Atomic HTGR core seismic verification program, 3:26434 (GA-A-14592)
REACTOR CORES/SPECIFICATIONS
Investigation of sodium-bonded carbide fuel assembly design (LMFBR), 3:26324
REACTOR FUEL ELEMENTS
See FUEL ELEMENTS
REACTOR FUELING
Method and device for inserting a multitude of fuel rods into a fuel element frame, 3:26392
Refuelling system for a nuclear reactor with a reactor core exhibiting a pebble bed of spherical fuel elements (Patent), 3:26267
REACTOR FUELS
See NUCLEAR FUELS
REACTOR INTERNALS/ACOUSTIC MONITORING
Instrumentation for the measurement of vibration in severe environments, such as nuclear reactors, 3:26374
REACTOR INTERNALS/MECHANICAL VIBRATIONS
Assessment of reactor internals vibration in BWR/4 and BWR/5 plants, 3:26207 (NEDO-24057)
REACTOR KINETICS/ONE-GROUP THEORY
Integral representation of the GREEN function for time-dependent processes in one-group diffusion approximation, 3:26347
REACTOR KINETICS/THREE-DIMENSIONAL CALCULATIONS
Two-group diffusion calculation through pseudo-continuous synthesis, 3:26352
REACTOR KINETICS EQUATIONS/CALCULATION METHODS
Identification of a nuclear reactor system by means of gradient methods, 3:26351
REACTOR LATTICES/POWER DENSITY
FLEX: a code for calculating neutron flux microdistributions in lattices consisting of hexagonal fuel assemblies, 3:26346
REACTOR LICENSING
Publication of safety criteria for nuclear power plants, dated 21st October 1977, 3:26334
REACTOR MATERIALS
(See also specific materials.)
See also NUCLEAR FUELS
REACTOR MATERIALS/CREEP
Titanium and titanium alloy creep (a bibliography with abstracts). Report for 1964-September 1977, 3:26598 (NTIS/PS-77/0803)
REACTOR NOISE
Studies on space dependence of the spectral density functions of neutron flux noise in pressurized water reactors, 3:26230
REACTOR NOISE/CORRELATION FUNCTIONS
Coherence analysis of boiling water reactor noise, 3:26220
REACTOR PROTECTION SYSTEMS/ELECTRICAL EQUIPMENT
Environmental qualification of safety-related Class 1E process instrumentation, 3:26445 (WCAP-9211)
REACTOR PROTECTION SYSTEMS/STANDARDS
Reactor protection system and supervision of protection equipment, 3:26456
REACTOR SAFETY
(Theoretical and experimental investigations of the behavior of reactor types and designs under various real or hypothetical accidents.)
See also FAULT TREE ANALYSIS
How safe is nuclear power, 3:26451
Nuclear power - a report on progress, 3:26452
Safety aspects of carbide irradiations in FTR driver positions, 3:26476
REACTOR SAFETY/REGULATIONS
Publication of safety criteria for nuclear power plants, dated 21st October 1977, 3:26334
REACTOR SAFETY/RESEARCH PROGRAMS
December 1977 monthly highlights for Office of Nuclear Regulatory Research Programs at Oak Ridge National Laboratory, 3:26441 (ORNL/NUREG/TM-182)
High-temperature gas-cooled reactor safety studies for the Division of Reactor Safety Research. Quarterly progress report, July 1-September 30, 1977, 3:26255 (ORNL/NUREG/TM-164)
U.S. advanced fuels safety program (LMFBR), 3:26312
REACTOR SITES/HYDROLOGY
Water consumption by nuclear powerplants and some hydrological implications, 3:26413 (USGS-CIRC-745)
REACTOR SITING
See SITE SELECTION
REACTOR VESSELS/SEALS
Process for the continuous control of the seal and strength of the containment of a reactor utilizing said process (Patent; LMFBR), 3:26289 (ANL-Trans-1111)
REACTOR VESSELS/THERMAL SHIELDS
Device for thermal shielding of a reactor vessel (Patent; LMFBR), 3:26285 (ANL-Trans-1121)
REACTOR VESSELS/THERMAL STRESSES
Steady-state stresses in concrete structures subjected to sustained and cyclically varying temperatures, 3:26363
REACTORS
See also GAS COOLED REACTORS
GRAPHITE MODERATED REACTORS
LIQUID METAL COOLED REACTORS
POWER REACTORS
WATER COOLED REACTORS
REACTORS/CRITICALITY
Fission reactor critical experiments and analysis, 3:26345 (LA-6807-PR)
REAL TIME SYSTEMS/ALGORITHMS
Software development of a real time signal processing system, 3:27707 (SAND-77-1684C)

REAL TIME SYSTEMS/DATA PROCESSING
Software development of a real time signal processing system, 3:27707 (SAND-77-1684C)
RECYCLE (FUEL)
See FUEL CYCLE
RED SEA/GEOTHERMAL SYSTEMS
Ore transport and deposition in the Red Sea geothermal system: a geochemical model, 3:26120
REFERENCE THETA PINCH REACTOR/PLASMA INSTABILITY
Plasma stabilization requirements of the reference theta-pinch reactor (RTPR), 3:27540 (EUR-5602)
REFINERY GASES/DESULFURIZATION
Corrosion control in gas processing plants which remove CO_2 and H_2S (Monoethanolamine), 3:25768
REFORMER PROCESSES/CATALYSTS
Catalytic reforming of naphtha cuts over polymetallic catalysts, 3:25772
REFRACTORIES/MANUFACTURING
Impact of alternate fuels on refractories and refractory insulations, 3:26629 (ORNL/TM-5895)
REFRACTORIES/THERMAL CONDUCTIVITY
Thermal conductivity of refractory materials in a wide range of temperatures and rarefunctions of a gaseous medium, 3:26642
REFRIGERATORS/ENERGY CONSERVATION
Energy-saving absorption liquid chillers, 3:26566
REFUSE
See SOLID WASTES
REFUSE DERIVED FUELS
See also INDUSTRIAL WASTES
MUNICIPAL WASTES
SOLID WASTES
SYNTHETIC FUELS
REFUSE DERIVED FUELS/COMBUSTION PROPERTIES
Processed refuse: a salvage fuel for existing boilers, 3:25974
REFUSE DERIVED FUELS/DEMAND FACTORS
Overcoming institutional barriers to solid waste utilization as an energy source. Final report, 3:26531 (HCP/L50172-01)
Overcoming institutional barriers to solid waste utilization as an energy source. Executive summary, 3:26532 (HCP/L50172-02)
REFUSE DERIVED FUELS/EVALUATION
Overcoming institutional barriers to solid waste utilization as an energy source. Final report, 3:26531 (HCP/L50172-01)
Overcoming institutional barriers to solid waste utilization as an energy source. Executive summary, 3:26532 (HCP/L50172-02)
REFUSE DERIVED FUELS/TECHNOLOGY ASSESSMENT
Technology evaluation of Army-scale waste-to-energy systems, 3:25973 (AD-A-042578)
REGGE CUTS
Simple interpretation of the Reggeon cutting rules, 3:27210
REGGE POLES/SYMMETRY
Many-particle Regge poles in supersymmetric theory, 3:27239
REINFORCED CONCRETE/BIBLIOGRAPHIES
Corrosion of reinforced concrete (citations from the NTIS data base). Report for 1964-Nov 77, 3:26656 (NTIS/PS-77/0966)
REINFORCED CONCRETE/CORROSION
Corrosion of reinforced concrete (citations from the NTIS data base). Report for 1964-Nov 77, 3:26656 (NTIS/PS-77/0966)
REINFORCED CONCRETE/ELASTICITY
Dynamical behavior of industrial structures made of reinforced concrete, 3:26384
RELATIVITY THEORY/MEASURE THEORY
Predictions of variations of the speed of light measured by stable clocks, 3:27406
REMOTE HANDLING EQUIPMENT
Device for dismounting fuel elements (Patent), 3:26389
REMOTE SENSING
Strip mining. Volume 2. 1976-October 1977 (citations from the NTIS data base). Report for 1976-Oct 77, 3:26919 (NTIS/PS-77/0951)
RESEARCH REACTORS
See also ACPR REACTOR
BER-2 REACTOR
FFTF REACTOR
JRR-4 REACTOR
NSRR REACTOR
RESEARCH REACTORS/DESIGN
New nuclear reactor being designed, 3:26425
RESERVOIR ENGINEERING/GAMMA-GAMMA LOGGING
Use of gamma-gamma logging in the operation of underground reservoirs for gas and petroleum products in rock salt deposits, 3:25823 (UCRL-Trans-11314)
RESERVOIR ROCK/PLUGGING
Laboratory investigations of permeability loss in sedimentary rocks (abstract), 3:26119
RESIDENTIAL SECTOR/POWER DEMAND
Supplement to "Technical Documentation of Staff Procedures for Estimating Peak Demand", 3:26527
RESIDUAL PETROLEUM/EVALUATION
Review of petroleum oil saturation and its determination, 3:25746 (BERC/RI-77/15)
RESIDUES
See also ASHES
RESIDUES/COKING
EDS coal liquefaction process development, Phase III B. Monthly technical progress report, December 1-December 31, 1977, 3:25660 (FE-2893-6)
RESIDUES/DISSOLUTION
Design and operation of air-lift, circulated, cascade dissolver systems, 3:26667 (RFP-2716)
RESIDUES/GASIFICATION
EDS coal liquefaction process development, Phase III B. Monthly technical progress report, December 1-December 31, 1977, 3:25660 (FE-2893-6)
RESIDUES (RADIOACTIVE)
See RADIOACTIVE WASTES
RESINS/BIOSYNTHESIS
Biochemical basis of paraquat induced oleoresin production in pines, 3:26025 (SRO-0888-2)
RESISTORS/COMPUTER-AIDED DESIGN
User/programmer guide for UCMD 47: thin film resistor layout, 3:26775 (SAND-77-2035)
RESONANCE PARTICLES
See also MESON RESONANCES
PSI-3105 RESONANCES
RESONANCE PARTICLES/HYDRODYNAMIC MODEL
Hydrodynamic model of collective resonances in hadronic matter, 3:27220
RESOURCE CONSERVATION/BUDGETS
Energy Resources Conservation and Development Commission 1978/79 budget, 3:26502
RESOURCES/COMPUTER GRAPHICS
Energy systems and statistics, 3:26505 (LA-6807-PR)
RESPIRATION
Effect of light on respiration and development of photosynthetic cells. Progress report, June 1, 1976-August 31, 1977 (Chlamydomonas, Euglena, spinach, peas), 3:26969 (COO-3231-5)
RETROFITTING/IMPLEMENTATION
Energy conservation retrofit process for existing public and institutional facilities, 3:26510
REVERSE-FIELD PINCH/EQUILIBRIUM PLASMA
Toroidal equilibrium of reverse field pinch, 3:27501 (CLM-R-164)
REVERSE-FIELD PINCH/LINERS
Design aspects of a large toroidal stabilizing shell and vacuum liner assembly, 3:27696 (EUR-5602)
REVERSE-FIELD PINCH/PLASMA INSTABILITY
Linear and non-linear calculation of the tearing mode in reversed field pinches, 3:27560
REVERSE-FIELD PINCH/PLASMA SIMULATION
Numerical simulation of Padua Eta-Beta reverse-field pinch, 3:27526
REVERSE-FIELD PINCH/SHELLS
Design aspects of a large toroidal stabilizing shell and vacuum liner assembly, 3:27696 (EUR-5602)
RHENIUM/EMISSIVITY
Integral hemispherical degree of blackness of alloys of high-melting metals at high temperatures, 3:26622
RHENIUM/ION EXCHANGE
Cation exchange of 53 elements in nitric acid, 3:26665 (LA-7083)
RHENIUM/SUPERCONDUCTIVITY
Oscillations of properties of thin superconducting films with varying coating thickness, 3:26624
RHENIUM ALLOYS/EMISSIVITY
Integral hemispherical degree of blackness of alloys of high-melting metals at high temperatures, 3:26622
RHENIUM FLUORIDES/MAGNETIC RESONANCE
Optical and zero field magnetic resonance spectroscopy of inorganic molecular solids. Final report, 1 June 1975-31 May 1977, 3:26645 (AD-A-043340)
RHENIUM FLUORIDES/OPTICAL PROPERTIES
Optical and zero field magnetic resonance spectroscopy of inorganic molecular solids. Final report, 1 June 1975-31 May 1977, 3:26645 (AD-A-043340)
RHO-765 RESONANCES/PARTICLE PRODUCTION
Inclusive rho^0 and f^0 production in 100-GeV/c p anti p interactions, 3:27128
Inclusive production of rho^0 in inelastic muon-nucleon scattering, 3:27102
RHO-765 RESONANCES/PHOTOPRODUCTION
Eikonal and quasi-eikonal models in the theory of complex angular momenta for pion elastic scattering and rho^0-meson photoproduction on ^{4}He nuclei, 3:27235
RHODANATES
See THIOCYANATES
RHODANIDES
See THIOCYANATES

RHODIUM/CATALYTIC EFFECTS
Studies on catalysts for low-temperature steam-reforming of hydrocarbons. IV. Kinetics of reaction on the Rh-$MgWO_4$ catalyst, 3:25784
RHODIUM/ION EXCHANGE
Cation exchange of 53 elements in nitric acid, 3:26665 (LA-7083)
RHODIUM 103 TARGET/NEUTRON REACTIONS
Cross sections for (n,2n) and (n,3n) reactions above 14 MeV, 3:27353
RHODOPSEUDOMONAS/REDOX REACTIONS
Annual progress report, September 1, 1976-November 30, 1977 (Chromophores in photosynthetic membranes and reaction centers of Rhodopseudomonas sp.), 3:26945 (COO-3162-36)
RIBONUCLEIC ACID
See RNA
RICHLAND FFTF REACTOR
See FFTF REACTOR
RIEMANN WAVES
See SHOCK WAVES
RINGS (STORAGE)
See STORAGE RINGS
RISER CRACKING
See COAL LIQUEFACTION
RIVETS
See FASTENERS
RNA
(Ribonucleic acid.)
RNA/BIOCHEMICAL REACTION KINETICS
Yeast mitochondrial DNA specifies tRNA for 19 amino acids. Deletion mapping of the tRNA genes, 3:26950
RNA/MOLECULAR STRUCTURE
Carbon magnetic resonance spectroscopy on carbon-13-labeled uracil in 5S ribonucleic acid, 3:26686
ROADS/BUILDING MATERIALS
Pavement recycling using a heavy bulldozer mounted pulverizer. Special report, 3:26554 (AD-A-046008)
ROCK BURSTS
Criterion for gas, coal and rock bursts, 3:25697
Investigations on effect of protecting pillars on coal and gas burst prevention in Ostrava-Karvina district coal mines, 3:25698
ROCK DRILLING/MATHEMATICAL MODELS
Multifactor mathematical models of the core drilling-out process by lateral drilling core catchers, 3:25753
ROCKS
See also IGNEOUS ROCKS
METAMORPHIC ROCKS
RESERVOIR ROCK
SEDIMENTARY ROCKS
ROCKS/CREEP
Non-linear least-square fitting approach for determining activation energies for high temperature creep (abstract), 3:26110
ROCKS/HYDRAULIC FRACTURING
Hydrology, 3:26896 (TID-26712)
ROCKS/POLLUTION
Environmental effect of mercury, with particular attention to the Monte Amiata Zone, 3:26885 (ORNL-tr-4479)
ROCKS/WASTE DISPOSAL
Preliminary environmental assessments of disposal of rock mined during excavation of a federal repository for radioactive waste, 3:25939 (Y/OWI/SUB-77/42503)
ROCKY FLATS PLANT/GAS CHROMATOGRAPHY
Application of a GC/MS data system at Rocky Flats (Analysis of organic compounds), 3:26839 (RFP-2558)
ROCKY FLATS PLANT/MASS SPECTROMETERS
Application of a GC/MS data system at Rocky Flats (Analysis of organic compounds), 3:26839 (RFP-2558)
ROCKY FLATS PLANT/RADIONUCLIDE MIGRATION
Solubility of plutonium and americium-241 from rumen contents of cattle grazing on plutonium-contaminated desert vegetation in in vitro bovine gastrointestinal fluids, November 1974-May 1975 (Uptake of transuranics by dairy cows from contaminated forage with emphasis on excretion in milk), 3:26914 (NVO-171)
ROCKY FLATS PLANT/TERRESTRIAL ECOSYSTEMS
Solubility of plutonium and americium-241 from rumen contents of cattle grazing on plutonium-contaminated desert vegetation in in vitro bovine gastrointestinal fluids, November 1974-May 1975 (Uptake of transuranics by dairy cows from contaminated forage with emphasis on excretion in milk), 3:26914 (NVO-171)
ROCKY MOUNTAIN REGION/AIR QUALITY
Energy systems and statistics, 3:26505 (LA-6807-PR)
ROCKY MOUNTAINS/GEOLOGY
Exploration frontiers of the central and southern Rockies, 3:25729
ROCKY MOUNTAINS/MEETINGS
Exploration frontiers of the central and southern Rockies, 3:25729
ROOFS/SEALS
Dry-process-sprayed coal mine sealants, an updated progress report, 3:25690 (BM-RI-8266)
ROOM AND PILLAR MINING/ROCK BURSTS
Investigations on effect of protecting pillars on coal and gas burst prevention in Ostrava-Karvina district coal mines, 3:25698
ROTORS/THERMAL STRESSES
Concentration of temperature stresses in thermal grooves of integral-disk rotors, 3:26173
RUBBER (NATURAL)
See NATURAL RUBBER
RUBBERS
See also NATURAL RUBBER
RUBBERS/MATERIALS RECOVERY
Cryogenic tire granulation, 3:26573
RUNAWAY (REACTOR ACCIDENT)
See EXCURSIONS
RUTHENIUM/ION EXCHANGE
Cation exchange of 53 elements in nitric acid, 3:26665 (LA-7083)
RUTHENIUM/SORPTIVE PROPERTIES
Evidence for the structures of adsorbed NH_3 and H_2O on RU(001), 3:25968 (AD-A-043330)
RUTHENIUM 106/ENVIRONMENTAL TRANSPORT
Ecology of Hanford 200 Area and 1976 radionuclide inventory, 3:25944 (PNL-2253)
RUTHENIUM 106/RADIATION MONITORING
Revegetation of a waste disposal site in the 200 areas of the Hanford Reservation, 3:26908 (PNL-2454)

S

S-1000 RESONANCES/MASS
Study of the reactions $\pi^- p \rightarrow \pi^+ \pi^- n$ and $\pi^- p \rightarrow K^+ K^- n$ at 1.98 and 2.41 GeV/c, 3:27143
SALT DEPOSITS/COMPATIBILITY
Compatibility testing of vitrified waste forms, 3:25936 (DP-MS-77-115)
SALT DEPOSITS/ENERGY YIELD
Geothermal energy from salt domes, 3:26082 (NP-23044)
SALT DEPOSITS/HEAT EXTRACTION
Geothermal energy from salt domes, 3:26082 (NP-23044)
SALTON SEA/HEAT FLOW
In situ thermal conductivity measurements for heat flow determinations in marine and lacustrine environments (abstract), 3:26094
SAMARIUM 148/ENERGY-LEVEL TRANSITIONS
Coulomb excitation in ^{148}Sm, 3:27364 (ANL-77-60)
SAMARIUM 155/ROTATIONAL STATES
Nuclear structure of ^{155}Sm, 3:27372 (ANL-77-60)
SAMARIUM COMPOUNDS/KNIGHT SHIFT
Systematics in the Knight shift of rare-earth monopnictides, 3:26600
SANDSTONES/PERMEABILITY
Laboratory investigations of permeability loss in sedimentary rocks (abstract), 3:26119
SAREF REACTOR/DESIGN
SAREF Project. Volume I. Conceptual design report, 3:26421 (ANL/SAREF-75-1)
SAVANNAH RIVER PLANT/RADIOACTIVE EFFLUENTS
Jeremiah environmental computational system (Monitoring radioactive effluents from nuclear fuel cycle), 3:26887 (DP-MS-77-41)
SAVANNAH RIVER PLANT/SNAKES
Snakes of the Savannah River Plant with information about snakebite prevention and treatment, 3:26894 (SRO-NERP-1)
SCALAR FIELDS/HIGGS MODEL
Super-Higgs effect in a new class of scalar models and a model of super QED, 3:27257
SCALAR FIELDS/SYMMETRY BREAKING
Internal symmetries and ghost symmetries, 3:27246
SCALE INVARIANCE/ELECTROPRODUCTION
Electroproduction of inclusive pions at high Q^2 (Cross sections, feynmon scaling), 3:27104
SCALE INVARIANCE/QUANTUM ELECTRODYNAMICS
Impact of quantum electrodynamics, 3:27255 (SLAC-PUB-1699)
SCALE INVARIANCE/SYMMETRY BREAKING
Broken gauge and scale invariance, 3:27253
SCANDIUM/ION EXCHANGE
Cation exchange of 53 elements in nitric acid, 3:26665 (LA-7083)
SCANDIUM/PHOTOEMISSION
X-ray photoemission spectra of the valence bands of the 3d transition metals, Sc to Fe, 3:26608
SCANDIUM 45 TARGET/NEUTRON REACTIONS
Cross sections for (n,2n) and (n,3n) reactions above 14 MeV, 3:27353

SCANDIUM CHLORIDES/CHEMICAL COMPOSITION
Metal-metal bonded clusters in transition metal groups 3 and 4. Synthesis and structure of three M_6X_{12}-type clusters for scandium and zirconium, 3:26677
SCANDIUM CHLORIDES/CRYSTAL STRUCTURE
Metal-metal bonded clusters in transition metal groups 3 and 4. Synthesis and structure of three M_6X_{12}-type clusters for scandium and zirconium, 3:26677
SCATTERING LENGTHS/GREEN FUNCTION
Some functional inequalities, with application to Green's function, 3:27409
SCHMEHAUSEN THTR REACTOR
See THTR-300 REACTOR
SCHROEDINGER EQUATION/ASYMPTOTIC SOLUTIONS
Nonlinear wave and soliton propagation in media with arbitrary inhomogeneities, 3:27417
SCHROEDINGER EQUATION/GREEN FUNCTION
Some functional inequalities, with application to Green's function, 3:27409
SCHROEDINGER EQUATION/INTEGRALS
Positivity of an integral connected with the helium atom problem, 3:27408
SCREWS
See FASTENERS
SCRUBBERS/OPERATION
Status of flue gas desulfurization applications in the United States: a technological assessment, 3:26194 (TID-28141)
SCRUBBERS/PERFORMANCE
Application of scrubbing systems to low sulfur/alkaline ash coals. Final report (Fly ash as scrubber reagent), 3:25678 (EPRI-FP-595)
Status of flue gas desulfurization applications in the United States: a technological assessment, 3:26194 (TID-28141)
Summary of the effects of important chemical variables upon the performance of lime/limestone wet scrubbing systems. Interim report, 3:25679 (EPRI-FP-639)
SCRUBBERS/PERFORMANCE TESTING
Emission testing and evaluation of Ford/Koppers coke pushing control system. Volume I. Final report. Report for Dec 73-Aug 77, 3:25684 (PB-273812)
Studies on nitrogen oxides removal from flue gas (No. 2), 3:26196
SCRUBBERS/SLUDGES
State-of-the-art of FGD sludge fixation. Final report, 3:25680 (EPRI-FP-671)
SCYLLAC DEVICES/RESEARCH PROGRAMS
High beta stellarator, a toroidal confinement system, 3:27607
SCYLLAC DEVICES/WAVE PROPAGATION
Observation of propagating m=1 waves in Scyllac, 3:27583
SEALS
See also GASKETS
SEALS/PERFORMANCE TESTING
Sodium technology and cover gas seal development programs. Quarterly technical progress report, July-September 1977 (LMFBR), 3:26274 (AI-DOE-13208)
SEAS
See also MEDITERRANEAN SEA
RED SEA
SALTON SEA
SEAS/HEAT FLOW
In situ thermal conductivity measurements for heat flow determinations in marine and lacustrine environments (abstract), 3:26094
SEAS/MINERAL CYCLING
Distribution of some chemical elements between dissolved and particulate phases in the ocean. Period covered: August 1, 1976-October 31, 1977 (Natural ^{210}Pb and ^{210}Po tracers), 3:26930 (COO-3566-19)
SEAWATER/CORROSIVE EFFECTS
Corrosion of reinforced concrete (citations from the NTIS data base). Report for 1964-Nov 77, 3:26656 (NTIS/PS-77/0966)
SECONDARY COOLANT CIRCUITS/VALVES
Back pressure: tight main steam isolating valves for PWRs, 3:26234
SEDIMENTARY ROCKS/ACTIVATION ANALYSIS
Uranium abundance in some Precambrian and Phanerozoic rocks from New Mexico, 3:25912
SEDIMENTS/POLLUTION
Environmental effect of mercury, with particular attention to the Monte Amiata Zone, 3:26885 (ORNL-tr-4479)
Transport and transformation pathways of hazardous chemicals from solid waste disposal, 3:26875 (CONF-7710114-1)
SEISMIC SURVEYS
Seismic stratigraphic exploration: a new frontier, 3:25735
SEISMIC SURVEYS/DATA ANALYSIS
Interpretation of seismic reflection data from the central South Park basin, Colorado, 3:25732
Seismic investigation of the Colorado Front Range Zone of flank deformation immediately north of Golden, Colorado, 3:25733
SEISMIC SURVEYS/DATA PROCESSING
Design of discrete nonadaptive operators for seismic data processing, 3:27010
SEISMIC SURVEYS/MEASURING METHODS
Application of CDP-stacked tapes to seismic exploration, 3:27012
Seismological methods and the search for geothermal resources, 3:26092
SEISMIC SURVEYS/RECORDING SYSTEMS
Dynamic range of reflection recording in seismic exploration, 3:27011
SELENIUM/ION EXCHANGE
Cation exchange of 53 elements in nitric acid, 3:26665 (LA-7083)
SELENIUM/QUANTITATIVE CHEMICAL ANALYSIS
Fate of trace and minor constituents of coal during gasification. Final task report, 3:25641 (PB-270913)
SEMICONDUCTOR DEVICES
See also SEMICONDUCTOR LASERS
TRANSISTORS
SEMICONDUCTOR DEVICES/MEETINGS
Physics of semiconductors, 3:26767
SEMICONDUCTOR LASERS/DESIGN
Fiber-optic-coupled LOC injection-laser array for 8500 angstroms room-temperature emission. Final report, 3:26724 (AD-A-042490)
SEMICONDUCTOR LASERS/MODE SELECTION
Electromagnetic modes of heterojunction injection lasers, 3:26764
SEMICONDUCTOR LASERS/OPTIMIZATION
C. W. GaAs diode laser. Final report 1 Dec 73-2 Dec 74, 3:26735 (AD-B-015785)
SEMICONDUCTOR LASERS/REVIEWS
Recent advances in heterojunction lasers, 3:26768
SEMICONDUCTOR MATERIALS
(See also specific semiconductor materials.)
SEMICONDUCTOR MATERIALS/ION IMPLANTATION
Semiconductor measurement technology: some aspects of dose measurement for accurate ion implantation, 3:26825 (PB-269776)
SENSIBLE HEAT STORAGE/MATHEMATICAL MODELS
Stratified versus well-mixed sensible heat storage in a solar space heating application, 3:26079 (COO/4511-2)
SENSIBLE HEAT STORAGE/PERFORMANCE
Passive technique for enhancing thermal stratification in liquid storage tanks, 3:26080 (COO/4511-2)
SENSIBLE HEAT STORAGE/RESEARCH PROGRAMS
CSU/DOE solar energy research program. Monthly progress report, November 1977, 3:26046 (COO/4511-2)
SENSIBLE HEAT STORAGE/STRATIFICATION
Passive technique for enhancing thermal stratification in liquid storage tanks, 3:26080 (COO/4511-2)
Stratified versus well-mixed sensible heat storage in a solar space heating application, 3:26079 (COO/4511-2)
SEWAGE
See LIQUID WASTES
SEWAGE/ANAEROBIC DIGESTION
ANFLOW treatment of municipal waste water, 3:26011 (COO/2991-19)
SEWAGE SLUDGE/ANAEROBIC DIGESTION
Best mixing concepts for refuse/sludge for ERDA's biogasification project, 3:26013 (COO/2991-19)
Enhancement of methane production with activated carbon, 3:26012 (COO/2991-19)
Heat treatment of organics for increasing anaerobic biodegradability. Quarterly progress report, March 1, 1977-May 31, 1977, 3:26007 (COO/2991-19)
SEWAGE SLUDGE/MIXING
Best mixing concepts for refuse/sludge for ERDA's biogasification project, 3:26013 (COO/2991-19)
SEWAGE SLUDGE/RADIOSTERILIZATION
Thermoradiation treats sewage sludge, 3:26576
SEWAGE SLUDGE/USES
Thermoradiation treats sewage sludge, 3:26576
SEWAGE SLUDGE/WASTE DISPOSAL
Utilization and disposal of wastes by photosynthetic bacteria, 3:26003
SEWAGE SLUDGE/WASTE PROCESSING
Utilization and disposal of wastes by photosynthetic bacteria, 3:26003
SEWAGE TREATMENT
See WASTE PROCESSING
SHAFT EXCAVATIONS
See also RADIOACTIVE WASTE DISPOSAL
SHAFT EXCAVATIONS/ENVIRONMENTAL IMPACTS
Preliminary environmental assessments of disposal of rock mined during excavation of a federal repository for radioactive waste, 3:25939 (Y/OWI/SUB-77/42503)
SHEATHS (FUEL)
See FUEL CANS
SHELLS (CONTAINMENT)
See CONTAINMENT SHELLS

SHIPS
See also SUBMARINES
TANKER SHIPS
SHIPS/BOILERS
Newly developed UTR type marine reheat boiler, 3:26589
SHIVA FACILITY
SHIVA Nd: glass disk-amplifier-assembly facility and special purpose fixtures, 3:27671 (UCID-17703)
SHOCK TUBES/SWITCHES
Technology and characteristics of breakdown and plasma in shock tube arrangements, 3:27489 (EUR-5602)
SHOCK WAVES/WAVE PROPAGATION
Impulse attenuation of waves emanating from a cylindrical cavity in anisotropic media, 3:27415
SI SEMICONDUCTOR DETECTORS/RESPONSE FUNCTIONS
Photon and electron response of silicon-diode neutron detectors, 3:26822
SID
See SUDDEN IONOSPHERIC DISTURBANCE
SIGMA-MINUS ATOMS
See HADRONIC ATOMS
SILICATES/STANDARDIZED TERMINOLOGY
Fine-grained sheet silicate rocks, 3:25940 (Y/OWI/SUB-7009/4)
SILICON/CASTING
Study program to develop and evaluate die and container materials. First quarterly report, October 1977-December 1977, 3:25988 (DOE/JPL/954877-1)
SILICON/CRYSTAL GROWTH
Silicon materials task of the low cost solar array project (Phase II). Seventh quarterly report, April 1, 1977-June 31, 1977, 3:25990 (ERDA/JPL/954331-77/3)
SILICON/ELECTRONIC STRUCTURE
Structural disorder and electronic properties of amorphous silicon, 3:26644
SILICON/NEUTRON SPECTRA
Neutron dosimetry standard. Final report, 1 May 1974-30 October 1975, 3:27403 (AD-A-042276)
SILICON/PHYSICAL RADIATION EFFECTS
Neutron dosimetry standard. Final report, 1 May 1974-30 October 1975, 3:27403 (AD-A-042276)
SILICON 28 TARGET/BERYLLIUM 9 REACTIONS
Low energy elastic scattering from ^{28}Si targets using projectiles with $9 < \text{or} = A < \text{or} = 18$, 3:27344
SILICON 28 TARGET/CARBON 12 REACTIONS
Low energy elastic scattering from ^{28}Si targets using projectiles with $9 < \text{or} = A < \text{or} = 18$, 3:27344
SILICON 28 TARGET/NITROGEN 14 REACTIONS
Low energy elastic scattering from ^{28}Si targets using projectiles with $9 < \text{or} = A < \text{or} = 18$, 3:27344
SILICON 28 TARGET/OXYGEN 16 REACTIONS
Low energy elastic scattering from ^{28}Si targets using projectiles with $9 < \text{or} = A < \text{or} = 18$, 3:27344
Surface transparent potentials: forward angle transfer and backward angle elastic scattering in heavy-ion collisions (Cross sections, tau, π), 3:27338 (BNL-23461)
SILICON 28 TARGET/OXYGEN 18 REACTIONS
Low energy elastic scattering from ^{28}Si targets using projectiles with $9 < \text{or} = A < \text{or} = 18$, 3:27344
SILICON ALLOYS/REFLECTIVITY
Thermomodulation spectra of the superconducting alloy $Nb_3(AlSi)$, 3:26626
SILICON ALLOYS/SPIN WAVES
Magnetic excitations in the weak itinerant ferromagnet MnSi, 3:26610
SILICON ALLOYS/SUPERCONDUCTIVITY
Thermomodulation spectra of the superconducting alloy $Nb_3(AlSi)$, 3:26626
SILICON CARBIDES/MATERIALS TESTING
Development of a ceramic tube heat exchanger with relaxing joint. Quarterly technical progress report, July-October 1, 1977, 3:26152 (FE-2556-09)
SILICON CARBIDES/MECHANICAL PROPERTIES
Ceramic technology readiness program. Third monthly technical progress report, November 28, 1977-January 1, 1978, 3:26144 (FE/2664-3)
SILICON CARBIDES/PHYSICAL PROPERTIES
Ceramic technology readiness program. Third monthly technical progress report, November 28, 1977-January 1, 1978, 3:26144 (FE/2664-3)
SILICON NITRIDES/MECHANICAL PROPERTIES
Ceramic technology readiness program. Third monthly technical progress report, November 28, 1977-January 1, 1978, 3:26144 (FE/2664-3)
SILICON NITRIDES/PHYSICAL PROPERTIES
Ceramic technology readiness program. Third monthly technical progress report, November 28, 1977-January 1, 1978, 3:26144 (FE/2664-3)
SILICON SOLAR CELLS/BIBLIOGRAPHIES
Silicon solar cells. Volume 1. 1964-September 1976 (citations from the NTIS data base). Report for 1964-Sep 76 (250 abstracts), 3:25991 (NTIS/PS-77/0955)
Silicon solar cells. Volume 2. October 1976-November 1977 (citations from the NTIS data base). Report for Oct 76-Nov 77 (187 abstracts), 3:25992 (NTIS/PS-77/0956)
Silicon solar cells. Volume 2. 1976-November 1977 (citations from the Engineering Index data base). Report for 1976-Nov 77 (120 abstracts), 3:25993 (NTIS/PS-77/0958)
SILICON SOLAR CELLS/CALIBRATION
Comparative performance of silicon and gallium arsenide solar cells on a high altitude sounding rocket, 3:25998
SILICON SOLAR CELLS/COMPUTER CALCULATIONS
Computer analysis of resistance and non-uniform illumination effects on concentrator solar cells, 3:25995 (SAND-77-1269C)
SILICON SOLAR CELLS/EFFICIENCY
Computer analysis of resistance and non-uniform illumination effects on concentrator solar cells, 3:25995 (SAND-77-1269C)
SILICON SOLAR CELLS/FABRICATION
Silicon materials task of the low cost solar array project (Phase II). Seventh quarterly report, April 1, 1977-June 31, 1977, 3:25990 (ERDA/JPL/954331-77/3)
SILICON SOLAR CELLS/MATERIALS TESTING
High efficiency solar panel (HESP). Final report, 1 June 1975-15 June 1977, 3:25987 (AD-A-043382)
SILICON SOLAR CELLS/RESEARCH PROGRAMS
CSU/DOE solar energy research program. Monthly progress report, November 1977, 3:26046 (COO/4511-2)
SILVER/ION EXCHANGE
Cation exchange of 53 elements in nitric acid, 3:26665 (LA-7083)
SILVER/PHYSICAL RADIATION EFFECTS
Radiation-annealing effects in energetic displacement cascades, 3:26628
SILVER 107 TARGET/PROTON REACTIONS
Anomalous optical-model potential for sub-Coulomb protons for $89 < A < 130$, 3:27361
SILVER 108 TARGET/NEUTRON REACTIONS
Coherent dissociation of neutrons on nuclei at 100-300 GeV/c, 3:27123
SILVER 109 TARGET/PROTON REACTIONS
Anomalous optical-model potential for sub-Coulomb protons for $89 < A < 130$, 3:27361
SILVER 122/BETA-MINUS DECAY
Decay of mass-separated ^{122}Ag to levels in ^{122}Cd (Transitions, isomeric half-life, tau, π), 3:27363 (IS-T-795)
SILVER 122/ISOMERIC NUCLEI
Decay of mass-separated ^{122}Ag to levels in ^{122}Cd (Transitions, isomeric half-life, tau, π), 3:27363 (IS-T-795)
SILVER-ZINC BATTERIES/ANODES
Research on alkaline zinc secondary electrodes with emphasis on life improvement. Annual progress report, June 15, 1976-March 15, 1977 (Linfield Research Inst., McMinnville, Oregon), 3:26490 (RLO/2434-1)
SINGLE CELL PROTEIN/BIOSYNTHESIS
Biomass production from animal wastes by photosynthetic bacteria, 3:26028
SINGLE-PARTICLE MODEL/INVARIANCE PRINCIPLES
Single-particle basis and translational invariance in microscopic nuclear calculations, 3:27388
SITE SELECTION/SOCIO-ECONOMIC FACTORS
Comments on the consequences of the setting up of a nuclear power plant, 3:26941
SITES (REACTOR)
See REACTOR SITES
SLAGS/WASTE PRODUCT UTILIZATION
Study of the effect of firing conditions upon flyash structural products. Report No. 128, 3:25683 (NP-23089)
SLUDGES/SOLIDIFICATION
State-of-the-art of FGD sludge fixation. Final report, 3:25680 (EPRI-FP-671)
SLUDGES/WASTE DISPOSAL
State-of-the-art of FGD sludge fixation. Final report, 3:25680 (EPRI-FP-671)
SLUGS (FUEL)
See FUEL RODS
SLURRIES (FUEL)
See FUEL SLURRIES
SMALL INTESTINE/BIOLOGICAL RADIATION EFFECTS
Ultrastructural characteristics of advanced radiation-induced adenocarcinoma in the small intestine of the rat (X radiation), 3:26986 (CONF-770504-)
SMALL INTESTINE/CARCINOMAS
Ultrastructural characteristics of advanced radiation-induced adenocarcinoma in the small intestine of the rat (X radiation), 3:26986 (CONF-770504-)
SNAKES/HABITAT
Snakes of the Savannah River Plant with information about snakebite prevention and treatment, 3:26894 (SRO-NERP-1)

SNAKES/VENOMS
Snakes of the Savannah River Plant with information about snakebite prevention and treatment, 3:26894 (SRO-NERP-1)
SODIUM/ABUNDANCE
Rare earth and other trace elements in historic Azorean lavas, 3:27009
SODIUM/ELECTRON-ATOM COLLISIONS
Nonresonant and resonant electron distributions from fast particle collisions: Application to sodium, 3:27069
SODIUM/FIRES
Extinction of metal fires, 3:26471
SODIUM/HEAVY ION REACTIONS
Proton and pion spectra at large angles in relativistic heavy-ion collisions (800 MeV/N), 3:27332 (LBL-670)
SODIUM/PURIFICATION
Installation for purifying the liquid metal used for cooling the core of a fast neutron reactor (Patent), 3:26287 (ANL-Trans-1113)
SODIUM/REMOVAL
Sodium technology and cover gas seal development programs. Quarterly technical progress report, July-September 1977 (LMFBR), 3:26274 (AI-DOE-13208)
SODIUM CHLORIDES/CHEMICAL REACTION KINETICS
Concentration dependence of activation free energies in electrolyte diffusion (abstract), 3:26115
SODIUM CHLORIDES/CRYSTAL STRUCTURE
Breakdown of the "white noise approximation" in the Moessbauer relaxation spectra: The case of $Cs_2NaYbCl_6$, 3:26653
SODIUM CHLORIDES/CRYSTAL-PHASE TRANSFORMATIONS
Search criterion for lattice internal rearrangement modes: Correlation between lattice structural and magnetic structural transitions, 3:26630
SODIUM CHLORIDES/DIFFUSION
Concentration dependence of activation free energies in electrolyte diffusion (abstract), 3:26115
SODIUM CHLORIDES/MAGNETOSTRICTION
Search criterion for lattice internal rearrangement modes: Correlation between lattice structural and magnetic structural transitions, 3:26630
SODIUM CHLORIDES/VISCOSITY
Viscosity of aqueous sodium chloride solutions from 0 to 150°C, 3:26114 (LBL-5931)
SODIUM SULFIDES/CRITICAL FIELD
Investigation of the heat capacity and of the superconducting properties of the sulfide Mo_6NaS_8, 3:26655
SODIUM SULFIDES/SPECIFIC HEAT
Investigation of the heat capacity and of the superconducting properties of the sulfide Mo_6NaS_8, 3:26655
SODIUM-SULFUR BATTERIES/OPERATION
European developments in the Na/S high- temperature battery for automobile propulsion and energy storage, 3:26487 (AD-A-042541)
SODIUM-SULFUR BATTERIES/RESEARCH PROGRAMS
Federal battery program for transportation uses, 3:26485 (CONF-7606127-1)
SOILS/EROSION
Geomorphology, 3:26900 (TID-26712)
SOILS/MINERAL CYCLING
Corrections and revisions to the FORTRAN IV version of the Wisconsin Hydrologic Transport Model, 3:27003 (ORNL/NSF/EATC-29)
SOILS/POLLUTION
Environmental effect of mercury, with particular attention to the Monte Amiata Zone, 3:26885 (ORNL-tr-4479)
Transport and transformation pathways of hazardous chemicals from solid waste disposal, 3:26875 (CONF-7710114-1)
SOILS/RADIONUCLIDE MIGRATION
Estimated inventory of plutonium and uranium radionuclides for vegetation in aged fallout areas, 3:26913 (NVO-171)
Influence of microbial activities on availability and biotransport of plutonium, 3:26916 (NVO-171)
Plutonium distribution in a desert pavement-desert mound soil system in area 11, 3:26910 (NVO-171)
Plutonium distribution in the environs of the Nevada Test Site: status report, 3:26911 (NVO-171)
SOLAR ABSORBERS/BLACK COATINGS
Ellipsometry in the study of selective radiation: absorbing surfaces, 3:26063
New chrome black selective absorbing surface, 3:26064
Selective black for absorption of solar energy (Patent), 3:26067
SOLAR ABSORBERS/SPECTRALLY SELECTIVE SURFACES
Optical properties of thin film refractory metals, 3:26069
Wavelength-selective surfaces for solar energy utilization, 3:26070
SOLAR ACTIVITY
See also SOLAR FLARES
SOLAR WIND
SOLAR X-RAY BURSTS
SOLAR ACTIVITY/TABLES
Solar-geo/physical data number 396, August 1977. Part II (comprehensive reports). Data for February 1977-January 1977 and miscellanea, 3:27028 (PB-273618)
Solar-geophysical data number 396, August 1977. Part I. (Prompt Reports). Data for July 1977-June 1977, 3:27027 (PB-273617)
SOLAR AIR CONDITIONERS/TOTAL ENERGY SYSTEMS
Conceptual design Solar Total Energy Large Scale Experiment number 1. Final report (For US Army installation at Fort Hood,Texas), 3:26039 (TID-28013)
SOLAR AIR CONDITIONING/DEMONSTRATION PROGRAMS
Solar heating and cooling demonstration program contractor's review. Summary and analysis of workshop and panel sessions, 3:26044 (CONF-771229-(Summ.))
SOLAR AIR CONDITIONING/MEETINGS
Solar energy-uses-systems-experience symposium and roundtable conference, 3:26043 (CONF-770246-)
SOLAR CELL ARRAYS/COVERINGS
Consideration of encapsulants for photovoltaic arrays in terrestrial applications, 3:25999
SOLAR CELL ARRAYS/MATERIALS TESTING
High efficiency solar panel (HESP). Final report, 1 June 1975-15 June 1977, 3:25987 (AD-A-043382)
SOLAR CELLS
See also CADMIUM SULFIDE SOLAR CELLS
GALLIUM ARSENIDE SOLAR CELLS
SILICON SOLAR CELLS
SOLAR CELLS/EFFICIENCY
Efficiencies of various methods for solar energy conversion, 3:25986 (AD-A-042584)
SOLAR CELLS/FRESNEL LENS
Solar cell 'eyes' with self operating solar adjustment, 3:26001
SOLAR CELLS/PARABOLIC REFLECTORS
Solar cell equipment with concentrating mirrors and radiator surfaces, 3:25997
SOLAR CELLS/SOLAR TRACKING
Solar cell 'eyes' with self operating solar adjustment, 3:26001
SOLAR COLLECTORS
See also CONCENTRATING COLLECTORS
FLAT PLATE COLLECTORS
SOLAR COLLECTORS/BLACK COATINGS
Selective black for absorption of solar energy (Patent), 3:26067
SOLAR COLLECTORS/DESIGN
Solar building panel concept for the supply of hot water, 3:26055
SOLAR COLLECTORS/EFFICIENCY
Solar building panel concept for the supply of hot water, 3:26055
SOLAR COLLECTORS/MATERIALS
Some chemical aspects of solar energy utilization, 3:26066
SOLAR COLLECTORS/PERFORMANCE TESTING
ASHRAE'S approach to solar collector test standards, 3:26074
Error analysis of solar collector performance data, 3:26073
SOLAR COLLECTORS/SIZE
Facts and figuring: sizing collectors for space heating, 3:26052
SOLAR COLLECTORS/SPECTRALLY SELECTIVE SURFACES
Comparison of solar photothermal coatings, 3:26071
Selective black for absorption of solar energy (Patent), 3:26067
SOLAR CONCENTRATORS
See also COMPOUND PARABOLIC CONCENTRATORS
SOLAR CONCENTRATORS/DESIGN
Line focus segmented mirror concentrator, 3:26076
Principles of fixed mirror solar concentrator (With tracking heat receiver), 3:26077
Solar collectors using total internal reflections, 3:26078
SOLAR CONCENTRATORS/OPTICAL REFLECTION
Laser ray trace and bi-directional reflectometry measurements of various solar concentrators, 3:26062 (SAND-77-1466C)
SOLAR CONCENTRATORS/PERFORMANCE
Line focus segmented mirror concentrator, 3:26076
Principles of fixed mirror solar concentrator (With tracking heat receiver), 3:26077
SOLAR CONCENTRATORS/PERFORMANCE TESTING
Laser ray trace and bi-directional reflectometry measurements of various solar concentrators, 3:26062 (SAND-77-1466C)
SOLAR COOLING SYSTEMS
See also SOLAR AIR CONDITIONING
See SOLAR AIR CONDITIONERS
SOLAR COOLING SYSTEMS/COMMERCIALIZATION
Summary of proceedings of solar heating and cooling commercialization workshop, 3:26047 (DSE/4017-1)
SOLAR COOLING SYSTEMS/DEMONSTRATION PROGRAMS
System definition study: Phase 1 of individual load center, solar heating and cooling residential project. Final report (Impact of solar/load management systems on utilities), 3:26048 (EPRI-ER-594)

SOLAR COOLING SYSTEMS/ECONOMICS
System definition study: Phase 1 of individual load center, solar heating and cooling residential project. Final report (Impact of solar/load management systems on utilities), 3:26048 (EPRI-ER-594)
SOLAR COOLING SYSTEMS/MANUALS
ERDA facilities solar design handbook, 3:26050 (LA-UR-77-186)
SOLAR COOLING SYSTEMS/MEETINGS
Summary of proceedings of solar heating and cooling commercialization workshop, 3:26047 (DSE/4017-1)
SOLAR COOLING SYSTEMS/RESEARCH PROGRAMS
CSU/DOE solar energy research program. Monthly progress report, November 1977, 3:26046 (COO/4511-2)
Solar energy research, 3:26049 (LA-6807-PR)
SOLAR CORONA
Solar-geophysical data number 396, August 1977. Part I. (Prompt Reports). Data for July 1977-June 1977, 3:27027 (PB-273617)
SOLAR DRYERS/DESIGN
Solar dryingin thin layers, 3:26058
SOLAR DRYERS/PERFORMANCE TESTING
Solar dryingin thin layers, 3:26058
SOLAR ENERGY/MEETINGS
Community leaders workshop on solar energy assessment. Final report, 3:25982 (RLO/2230/T5-1)
Optics in solar energy utilization II , 3:25983
SOLAR ENERGY CONVERSION/HYDROGEN PRODUCTION
Efficiencies of various methods for solar energy conversion, 3:25986 (AD-A-042584)
SOLAR ENERGY CONVERSION/REVIEWS
Efficiencies of various methods for solar energy conversion, 3:25986 (AD-A-042584)
SOLAR FLARES/TABLES
Solar-geo/physical data number 396, August 1977. Part II (comprehensive reports). Data for February 1977-January 1977 and miscellanea, 3:27028 (PB-273618)
Solar-geophysical data number 396, August 1977. Part I. (Prompt Reports). Data for July 1977-June 1977, 3:27027 (PB-273617)
SOLAR HEAT ENGINES/EFFICIENCY
Efficiencies of various methods for solar energy conversion, 3:25986 (AD-A-042584)
SOLAR HEAT ENGINES/OPERATION
Hot air motors for thermal conversion of solar energy (Stirling and Ericsson cyclesj), 3:26057
SOLAR HEATING SYSTEMS/COMMERCIALIZATION
Summary of proceedings of solar heating and cooling commercialization workshop, 3:26047 (DSE/4017-1)
SOLAR HEATING SYSTEMS/DEMONSTRATION PROGRAMS
System definition study: Phase 1 of individual load center, solar heating and cooling residential project. Final report (Impact of solar/load management systems on utilities), 3:26048 (EPRI-ER-594)
SOLAR HEATING SYSTEMS/DESIGN
Facts and figuring: sizing collectors for space heating, 3:26052
SOLAR HEATING SYSTEMS/ECONOMICS
System definition study: Phase 1 of individual load center, solar heating and cooling residential project. Final report (Impact of solar/load management systems on utilities), 3:26048 (EPRI-ER-594)
SOLAR HEATING SYSTEMS/INSTALLATION
Installation and maintenance of solar heating systems, 3:26053
SOLAR HEATING SYSTEMS/LIFE-CYCLE COST
Impacts of the national energy programme on solar economics, 3:26051 (LA-UR-78-131)
Market evaluation study: solar heating and domestic hot water heating in DOD buildings. Final report, 3:26042 (AD-A-042178)
SOLAR HEATING SYSTEMS/MAINTENANCE
Installation and maintenance of solar heating systems, 3:26053
SOLAR HEATING SYSTEMS/MANUALS
ERDA facilities solar design handbook, 3:26050 (LA-UR-77-186)
Installation and maintenance of solar heating systems, 3:26053
SOLAR HEATING SYSTEMS/MARKET
Market evaluation study: solar heating and domestic hot water heating in DOD buildings. Final report, 3:26042 (AD-A-042178)
SOLAR HEATING SYSTEMS/MEETINGS
Summary of proceedings of solar heating and cooling commercialization workshop, 3:26047 (DSE/4017-1)
SOLAR HEATING SYSTEMS/PERFORMANCE
Solar house heating system using reflective pyramid optical condensing system. Final report. Evaluation of performance, June 1, 1975-December 31, 1976, 3:26045 (COO/2769-2)
SOLAR HEATING SYSTEMS/RESEARCH PROGRAMS
CSU/DOE solar energy research program. Monthly progress report, November 1977, 3:26046 (COO/4511-2)
Solar energy research, 3:26049 (LA-6807-PR)
SOLAR HEATING SYSTEMS/SENSIBLE HEAT STORAGE
Passive technique for enhancing thermal stratification in liquid storage tanks, 3:26080 (COO/4511-2)
Stratified versus well-mixed sensible heat storage in a solar space heating application, 3:26079 (COO/4511-2)
SOLAR HEATING SYSTEMS/TOTAL ENERGY SYSTEMS
Conceptual design Solar Total Energy Large Scale Experiment number 1. Final report (For US Army installation at Fort Hood,Texas), 3:26039 (TID-28013)
SOLAR NEUTRINOS
Solar neutrinos and the role of exchange currents in the pp reaction, 3:27233
SOLAR PROCESS HEAT/RESEARCH PROGRAMS
Solar energy research, 3:26049 (LA-6807-PR)
SOLAR RADIOWAVE RADIATION/TABLES
Solar-geo/physical data number 396, August 1977. Part II (comprehensive reports). Data for February 1977-January 1977 and miscellanea, 3:27028 (PB-273618)
Solar-geophysical data number 396, August 1977. Part I. (Prompt Reports). Data for July 1977-June 1977, 3:27027 (PB-273617)
SOLAR SPACE HEATING/DEMONSTRATION PROGRAMS
Solar heating and cooling demonstration program contractor's review. Summary and analysis of workshop and panel sessions, 3:26044 (CONF-771229-(Summ.))
SOLAR SPACE HEATING/ECONOMICS
Prospects for solar energy: the impact of the National Energy Plan (Economic analysis of solar space heating and solar water heating by state), 3:25985 (LA-7064-MS)
SOLAR SPACE HEATING/FINANCIAL INCENTIVES
Prospects for solar energy: the impact of the National Energy Plan (Economic analysis of solar space heating and solar water heating by state), 3:25985 (LA-7064-MS)
SOLAR SPACE HEATING/MEETINGS
Solar energy-uses-systems-experience symposium and roundtable conference, 3:26043 (CONF-770246-)
SOLAR SPACE HEATING/REGIONAL ANALYSIS
Impacts of the national energy programme on solar economics, 3:26051 (LA-UR-78-131)
SOLAR THERMAL POWER PLANTS/COMPARATIVE EVALUATIONS
Projection of distributed-collector solar-thermal electric power plant economics to years 1990-2000, 3:26038 (DOE/JPL/1060-1)
SOLAR THERMAL POWER PLANTS/ECONOMICS
Projection of distributed-collector solar-thermal electric power plant economics to years 1990-2000, 3:26038 (DOE/JPL/1060-1)
SOLAR THERMAL POWER PLANTS/ENERGY STORAGE
Value of energy storage for direct-replacement solar thermal power plants, 3:26032 (CONF-780216-2)
SOLAR THERMAL POWER PLANTS/MATHEMATICAL MODELS
STEAEC: Solar Thermal Electric Annual Energy Calculator documentation, 3:26033 (SAND-77-8278)
SOLAR THERMAL POWER PLANTS/PERFORMANCE
STEAEC: Solar Thermal Electric Annual Energy Calculator documentation, 3:26033 (SAND-77-8278)
SOLAR THERMAL POWER PLANTS/TOTAL ENERGY SYSTEMS
Conceptual design Solar Total Energy Large Scale Experiment number 1. Final report (For US Army installation at Fort Hood,Texas), 3:26039 (TID-28013)
SOLAR TRACKING/SERVOMECHANISMS
Solar cell 'eyes' with self operating solar adjustment, 3:26001
SOLAR WATER HEATERS/DEMONSTRATION PROGRAMS
System definition study: Phase 1 of individual load center, solar heating and cooling residential project. Final report (Impact of solar/load management systems on utilities), 3:26048 (EPRI-ER-594)
SOLAR WATER HEATERS/DESIGN
Solar building panel concept for the supply of hot water, 3:26055
Tap water heating with solar energy, 3:26054
SOLAR WATER HEATERS/ECONOMICS
System definition study: Phase 1 of individual load center, solar heating and cooling residential project. Final report (Impact of solar/load management systems on utilities), 3:26048 (EPRI-ER-594)
SOLAR WATER HEATERS/EFFICIENCY
Solar building panel concept for the supply of hot water, 3:26055
SOLAR WATER HEATERS/INSTALLATION
Installation and maintenance of solar heating systems, 3:26053
SOLAR WATER HEATERS/LIFE-CYCLE COST
Impacts of the national energy programme on solar economics, 3:26051 (LA-UR-78-131)
SOLAR WATER HEATERS/MAINTENANCE
Installation and maintenance of solar heating systems, 3:26053
SOLAR WATER HEATERS/MANUALS
ERDA facilities solar design handbook, 3:26050 (LA-UR-77-186)
Installation and maintenance of solar heating systems, 3:26053
SOLAR WATER HEATERS/RESEARCH PROGRAMS
CSU/DOE solar energy research program. Monthly progress report, November 1977, 3:26046 (COO/4511-2)

SOLAR WATER HEATERS/SOLAR COLLECTORS
Solar building panel concept for the supply of hot water, 3:26055
SOLAR WATER HEATERS/TOTAL ENERGY SYSTEMS
Conceptual design Solar Total Energy Large Scale Experiment number 1. Final report (For US Army installation at Fort Hood,Texas), 3:26039 (TID-28013)
SOLAR WATER HEATING/DEMONSTRATION PROGRAMS
Solar heating and cooling demonstration program contractor's review. Summary and analysis of workshop and panel sessions, 3:26044 (CONF-771229-(Summ.))
SOLAR WATER HEATING/ECONOMICS
Prospects for solar energy: the impact of the National Energy Plan (Economic analysis of solar space heating and solar water heating by state), 3:25985 (LA-7064-MS)
SOLAR WATER HEATING/FINANCIAL INCENTIVES
Prospects for solar energy: the impact of the National Energy Plan (Economic analysis of solar space heating and solar water heating by state), 3:25985 (LA-7064-MS)
SOLAR WATER HEATING/LIFE-CYCLE COST
Market evaluation study: solar heating and domestic hot water heating in DOD buildings. Final report, 3:26042 (AD-A-042178)
SOLAR WATER HEATING/MEETINGS
Solar energy-uses-systems-experience symposium and roundtable conference, 3:26043 (CONF-770246-)
SOLAR WATER HEATING/REGIONAL ANALYSIS
Impacts of the national energy programme on solar economics, 3:26051 (LA-UR-78-131)
SOLAR WIND/TABLES
Solar-geophysical data number 396, August 1977. Part I. (Prompt Reports). Data for July 1977-June 1977, 3:27027 (PB-273617)
SOLAR X-RAY BURSTS/TABLES
Solar-geophysical data number 396, August 1977. Part I. (Prompt Reports). Data for July 1977-June 1977, 3:27027 (PB-273617)
SOLID STATE LASERS/DESIGN
Picosecond source of coherent optical radiation tunable over the 350 to 680 nm range of wavelengths ($LiIO_3$), 3:26756
SOLID STATE LASERS/OPERATION
Single-frequency garnet laser with a waveguide resonator, 3:26760
SOLID STATE LASERS/RESEARCH PROGRAMS
Advanced lasers for power production, 3:27678 (UCRL-52000-77-8)
SOLID WASTES
See also AGRICULTURAL WASTES
REFUSE DERIVED FUELS
SOLID WASTES/CHEMICAL ANALYSIS
Fate of trace and minor constituents of coal during gasification. Final task report, 3:25641 (PB-270913)
SOLID WASTES/ECOLOGICAL CONCENTRATION
Transport and transformation pathways of hazardous chemicals from solid waste disposal, 3:26875 (CONF-7710114-1)
SOLID WASTES/ENERGY SOURCES
Overcoming institutional barriers to solid waste utilization as an energy source. Final report, 3:26531 (HCP/L50172-01)
Overcoming institutional barriers to solid waste utilization as an energy source. Executive summary, 3:26532 (HCP/L50172-02)
SOLID WASTES/HEALTH HAZARDS
Transport and transformation pathways of hazardous chemicals from solid waste disposal, 3:26875 (CONF-7710114-1)
SOLID WASTES/SAMPLING
Environmental aspects of the HYGAS Process, 3:25624 (CONF-780305-10)
SOLID WASTES/WASTE DISPOSAL
Solid waste disposal economics (a bibliography with abstracts). Report for 1964-September 1977, 3:26574 (NTIS/PS-77/0790)
Transport and transformation pathways of hazardous chemicals from solid waste disposal, 3:26875 (CONF-7710114-1)
SOLIDS/WAVE PROPAGATION
Impulse attenuation of waves emanating from a cylindrical cavity in anisotropic media, 3:27415
SOLITONS
Nonlinear wave and soliton propagation in media with arbitrary inhomogeneities, 3:27417
SOLITONS/WAVE PROPAGATION
Diverging solitons and their transition to dispersive waves, 3:27574
Effects of an ion beam on the motion of solitons in an ion beam-plasma system, 3:27576
SOLVATED ELECTRONS/CHEMICAL REACTIONS
Reactions of thiophene with radiolytically produced radicals. II. The solvated electron and the hydrogen atom, 3:26696
SOLVENT-REFINED COAL/COMBUSTION PROPERTIES
Characteristics of solvent refined coal: dual register burner tests. Final report, 3:25711 (EPRI-FP-628)
SOLVENT-REFINED COAL/DEASHING
Solvent refined coal (SRC) process operation of solvent refined coal pilot plant at Wilsonville, Alabama. Annual report, January-December 1976, 3:25648 (EPRI-AF-585)
SOLVENT-REFINED COAL/GRINDING
Characteristics of solvent refined coal: dual register burner tests. Final report, 3:25711 (EPRI-FP-628)
SOLVENT-REFINED COAL/SOLIDIFICATION
Solvent refined coal (SRC) process operation of solvent refined coal pilot plant at Wilsonville, Alabama. Annual report, January-December 1976, 3:25648 (EPRI-AF-585)
SOMATIC CELLS/GENETICS
Cellular heredity in haploid cultures of somatic cells. Annual progress report, April 1976-July 1977, 3:26960 (COO-3110-28)
SOMATIC CELLS/HAPLOIDY
Cellular heredity in haploid cultures of somatic cells. Annual progress report, April 1976-July 1977, 3:26960 (COO-3110-28)
SOVIET UNION
See USSR
SPACE POWER REACTORS/HEAT PIPES
Reactor and advanced heat transfer technology, 3:26705 (LA-6807-PR)
SPACE REFLECTION
See P INVARIANCE
SPACE VEHICLES/THERMAL ENERGY STORAGE EQUIPMENT
Evaluation of eutectic fluoride thermal energy storage unit compatibility. II. Test procedures and post-test evaluation results. Interim technical report, October 1975-June 1976, 3:26482 (AD-A-042234)
SPACECRAFT POWER SUPPLIES/MATERIALS TESTING
High efficiency solar panel (HESP). Final report, 1 June 1975-15 June 1977, 3:25987 (AD-A-043382)
SPACECRAFT POWER SUPPLIES/SATELLITES
Solar cell equipment with concentrating mirrors and radiator surfaces, 3:25997
SPACECRAFT POWER SUPPLIES/SOLAR CELLS
Solar cell equipment with concentrating mirrors and radiator surfaces, 3:25997
SPACERS/DESIGN
Spacer for nuclear reactor fuel rods, 3:26398
Spacers for fuel elements with a large number of fuel rods (Patent), 3:26400
SPARK CHAMBERS/PERFORMANCE
Exotic 4π detector for ISABELLE, 3:26806 (BNL-23534)
SPEAR
(2.5-GeV electron--positron storage ring at SLAC, Stanford University.)
SPEAR/BEAM PULSERS
Fast pulse beam generation systems for electron accelerators, 3:26797 (SLAC-PUB-1948)
SPEAR/USES
Opportunities to produce coherent soft x-rays at Stanford, 3:26740 (RLO/2230/T4-191)
SPECIFIC GRAVITY
See DENSITY
SPECIFIC WEIGHT
See DENSITY
SPECTRALLY SELECTIVE SURFACES/CHEMICAL VAPOR DEPOSITION
Optical properties of thin film refractory metals (Spectrally selective surfaces for solar absorbers), 3:26069
SPECTRALLY SELECTIVE SURFACES/COST
Comparison of solar photothermal coatings, 3:26071
SPECTRALLY SELECTIVE SURFACES/EMISSIVITY
Black chrome on commercially electroplated tin as a solar selective coating, 3:26061 (ERDA/NASA/1060-77/1)
SPECTRALLY SELECTIVE SURFACES/FABRICATION
Cadmium stannate selective optical films for solar energy applications. Semi-annual progress report 1 Jan-30 Jun 75, 3:25994 (PB-273038)
Improved black nickel coatings for flat plate solar collectors, 3:26072
New chrome black selective absorbing surface, 3:26064
SPECTRALLY SELECTIVE SURFACES/OPTICAL PROPERTIES
Improved black nickel coatings for flat plate solar collectors, 3:26072
New chrome black selective absorbing surface, 3:26064
Optical properties of thin film refractory metals (Spectrally selective surfaces for solar absorbers), 3:26069
Selective black for absorption of solar energy (Patent), 3:26067
SPECTRALLY SELECTIVE SURFACES/OPTIMIZATION
Optimization of coatings for flat plate solar collectors, Phase II. Final report, 28 June 1976-27 June 1977, 3:26060 (COO-2930-12)
SPECTRALLY SELECTIVE SURFACES/PERFORMANCE TESTING
Ellipsometry in the study of selective radiation: absorbing surfaces, 3:26063
SPECTRALLY SELECTIVE SURFACES/REFLECTIVITY
Black chrome on commercially electroplated tin as a solar selective coating, 3:26061 (ERDA/NASA/1060-77/1)

Ellipsometry in the study of selective radiation: absorbing surfaces, 3:26063
SPECTRALLY SELECTIVE SURFACES/REVIEWS
Comparison of solar photothermal coatings, 3:26071
Wavelength-selective surfaces for solar energy utilization, 3:26070
SPECTROPHOTOMETERS
Laser spectroscopy for continuous combustion applications, 3:26700 (BMI-1982)
SPERMATOZOA/ULTRASTRUCTURAL CHANGES
Morphology and ultrastructure of spermatozoa of the ticks, 3:26980 (CONF-770504-)
SPHERATOR/ELECTRON BEAMS
Experimental studies on generation and behaviour of field-reversing E- and P-layers, 3:27494
SPHERICAL MODEL/VIBRATIONAL STATES
Microscopic theory of nuclear quadrupole excitations, 3:27389
SPINACH/PHOTOSYNTHESIS
Effect of light on respiration and development of photosynthetic cells. Progress report, June 1, 1976-August 31, 1977 (Chlamydomonas, Euglena, spinach, peas), 3:26969 (COO-3231-5)
SPLEEN/METABOLISM
Splenic remodeling of red cell surfaces, 3:26963
SPONTANEOUS FISSION/REVIEWS
Experimental investigation of spontaneously fissile isomers, 3:27386
SPORADIC E/ELECTRON TEMPERATURE
Observations of electron temperature gradients in mid-latitude E sub S layers. Revision. Interim report, 3:27036 (AD-A-042501)
SPRAY PONDS
See COOLING PONDS
SRC PROCESS
Enthalpy measurement of coal-derived liquids. Quarterly technical progress report, October-December 1977 (SRC-1 naphtha: 160 to 670°F and 30 to 900 psia), 3:25652 (FE-2035-10)
SRC PROCESS/PILOT PLANTS
Solvent refined coal (SRC) process operation of solvent refined coal pilot plant at Wilsonville, Alabama. Annual report, January-December 1976, 3:25648 (EPRI-AF-585)
SRC-II PROCESS/RESIDUES
Gasification of residual materials from coal liquefaction. Evaluation of SRC II vacuum flash drum bottoms as feedstock to the Texaco Coal Gasification Process, 3:25632 (FE-2247-9R)
STAINLESS STEEL-304/CORROSION
Sodium technology and cover gas seal development programs. Quarterly technical progress report, July-September 1977 (LMFBR), 3:26274 (AI-DOE-13208)
STAINLESS STEEL-304/PHYSICAL RADIATION EFFECTS
Mixed-nitride fuel performance in EBR-II (LMFBR), 3:26306
STAINLESS STEEL-304L/COMPATIBILITY
Compatibility testing of vitrified waste forms, 3:25936 (DP-MS-77-115)
STAINLESS STEEL-304L/CORROSION PROTECTION
Development and evaluation of high chromium weld deposited overlays to protect less alloyed substrates from corrosion in a coal gasification atmosphere. Technical status report, December 1-December 31, 1977, 3:25643 (TID-28187)
STAINLESS STEEL-310/OXIDATION
Failure of the thermocouple assembly from the HYGAS coal pretreatment vessel: failure analysis report, 3:25621 (ANL/MSD/FE-77-6R)
STAINLESS STEEL-316/PHYSICAL RADIATION EFFECTS
Correlation between properties and irradiation behavior for carbide, carbonitride and nitride fuels (LMFBR), 3:26316
Experience and future plan of fast reactor oxide fuels irradiation in Japan, 3:26301
French irradiation test experience for carbide fuels (LMFBR), 3:26309
Irradiation behavior of sphere-pac carbide fuel (LMFBR), 3:26310
Irradiation performance analysis of UK fast reactor fuel (LMFBR), 3:26317
Mechanical behavior of a fuel pin for fast reactors: effect of the fuel form and of the approach-to-power on the change of the fuel stack length under irradiation, 3:26302
Mixed-nitride fuel performance in EBR-II (LMFBR), 3:26306
STAINLESS STEELS
See also STAINLESS STEEL-304
STAINLESS STEEL-304L
STAINLESS STEEL-310
STAINLESS STEEL-316
STAINLESS STEELS/CORROSION
Thermodynamic phase stability diagrams for the analysis of corrosion reactions in coal gasification/combustion atmospheres. Interim report, 3:25626 (EPRI-FP-539)
STAINLESS STEELS/PHYSICAL RADIATION EFFECTS
US experience in irradiation testing of advanced oxide fuels (LMFBR), 3:26303
STANDARDS/TABLES
RDT Standards index, 3:26331 (RDT-INDEX-(1-78))
STANDING CROP
See BIOMASS
STANFORD LINEAR ACCELERATOR CENTER/BEAM PULSERS
Fast pulse beam generation systems for electron accelerators, 3:26797 (SLAC-PUB-1948)
STANFORD LINEAR ACCELERATOR CENTER/COLLIDING BEAMS
Present and future colliding beam facilities at SLAC, 3:26813 (SLAC-PUB-1971)
STATISTICAL MODELS/LEVEL WIDTHS
Statistical model radiation widths for $75 < A < 130$ and the enhancement of p-wave neutron capture for $A \cong 90$, 3:27362
STEADY FLOW/EQUILIBRIUM
Mode crossing in a Lagrangian system, 3:27090
STEAM GENERATORS
Boiler (Patent), 3:26246
Burst protection for containers under high pressure, in particular steam generators (Patent), 3:26252
STEAM GENERATORS/CONTROL
Automation of a power block with combined circulation of a medium in the boiler under normal operating and emergency load-shedding conditions, 3:26176
STEAM GENERATORS/CORROSION PROTECTION
Corrosivity of flue gases from supercritical steam generators in operation on high-sulfur oil, 3:26155
STEAM GENERATORS/EFFICIENCY
Effectiveness of high-sulfur oil combustion within range of loads in the furnace of the TGMP-314 steam generator, 3:26154
STEAM GENERATORS/FUEL ECONOMY
Optimal maintenance of main steam parameters in accordance with load of a generating unit, 3:26156
STEAM GENERATORS/HEAT TRANSFER
Development of the furnace process with various vortex burner arrangements, 3:26157
STEAM GENERATORS/PERFORMANCE
Development of the furnace process with various vortex burner arrangements, 3:26157
STEAM GENERATORS/PERFORMANCE TESTING
Full scale tests and thermal design correlation for coiled once-through steam generators, 3:26184
STEAM SEPARATORS/DESIGN
Vapor separator for a nuclear reactor plant (Patent), 3:26372
STEAM SUPERHEATERS
See SUPERHEATERS
STEAM SYSTEMS/RELIEF VALVES
Nuclear power plant with a heat exchanger serving as steam generator (Patent), 3:26480
STEAM TURBINES
Steam turbines, 3:26367
STEAM TURBINES/COOLING SYSTEMS
Investigation of cooling-down conditions of the K-200-130 turbine of a drum boiler-type power block, 3:26172
STEAM TURBINES/CORROSION PRODUCTS
Formation of deposits of poorly soluble corrosion products, 3:26160
STEAM TURBINES/EFFICIENCY
Effect of thermal resistance of network water heaters on the operation of a t-250/300-240 turbine plant in variable conditions, 3:26179
STEAM TURBINES/MAINTENANCE
Chemical purging of K-300-240 turbines made at Kharkov Turbogenerator Works during overhauls, 3:26174
STEAM TURBINES/OPERATION
Obtaining thermal experimental multifactorial analytical characteristics of turbo-sets by utilizing the experiment planning method, 3:26175
STEAM TURBINES/ROTORS
Concentration of temperature stresses in thermal grooves of integral-disk rotors, 3:26173
STEAM-IRON PROCESS/DEMONSTRATION PROGRAMS
Development of the steam-iron process for hydrogen production. Project 9010 quarterly report No. 4, April 1-June 30, 1977, 3:25961 (FE-2435-16)
STEEL-ASTM-A516/COMPATIBILITY
Compatibility testing of vitrified waste forms, 3:25936 (DP-MS-77-115)
STEELS
See also CARBON STEELS
STAINLESS STEELS
STEELS/CORROSION
Study of plant metallurgical requirements for low-Btu gasification of coal for electric power generation, 3:25629 (FE-1545-39)
STEELS/CORROSION PROTECTION
Protection of steel and zinc-alloyed steel in power plants with Goldschmidt-products, 3:26186
STEELS/FRACTURE PROPERTIES
Brittle fracture initiation characteristics of thin mild steel plate for the gas barrier of LNG underground membrane tank, 3:25884

Structural integrity of water reactor pressure boundary components. Progress report for period ending 28 February 1977, 3:26430 (AD-A-042219)
STEELS/MATERIALS RECOVERY
Cryogenic tire granulation, 3:26573
STEELS/RADIATION EFFECTS
Structural integrity of water reactor pressure boundary components. Progress report for period ending 28 February 1977, 3:26430 (AD-A-042219)
STELLARATORS
See also PULSATOR STELLARATOR
SPHERATOR
URAGAN STELLARATOR
STELLARATORS/EQUILIBRIUM PLASMA
Magnetohydrodynamic equilibria of a non-circular cross-section stellarator, 3:27528
STELLARATORS/HIGH-FREQUENCY HEATING
Plasma heating in a toroidal system by a helical quadrupole RF field with $\omega < \omega$sub(Bi), 3:27452
STELLARATORS/KINK INSTABILITY
Magnetohydrodynamic instabilities in a current-carrying stellarator, 3:27559
STELLARATORS/MAGNETOHYDRODYNAMICS
Magnetohydrodynamic equilibria of a non-circular cross-section stellarator, 3:27528
STELLARATORS/NEUTRAL ATOM BEAM INJECTION
Possibility of medium energy neutral beam injection into stellarator reactor, 3:27430 (IPPJ-252)
STELLARATORS/PLASMA MACROINSTABILITIES
Magnetohydrodynamic instabilities in a current-carrying stellarator, 3:27559
STELLARATORS/STRESS ANALYSIS
Stress analysis of supporting tube of helical winding in stellarator device, 3:27632 (IPPJ-T-25)
STIRLING ENGINES/EXHAUST GASES
Stirling engine: an option for underground mines, 3:26577 (BERC/RI-78/3)
STIRLING ENGINES/MATERIALS
Materials technology assessment for Stirling engines, 3:26578 (CONS/1011-22)
STIRLING ENGINES/OPERATION
Hot air motors for thermal conversion of solar energy, 3:26057
STORAGE FACILITIES
See also NATURAL GAS
PETROLEUM
TERMINAL FACILITIES
STORAGE FACILITIES/SHIELDED METAL-ARC WELDING
Application of automatic gas shield arc welding to the vertical butt joint of an oil storage tank shell, 3:25822
STORAGE RINGS
See also ISABELLE STORAGE RINGS
PEP STORAGE RINGS
SPEAR
STORAGE RINGS/BEAM DYNAMICS
Quantum lifetime in electron storage rings, 3:26811 (SLAC-PUB-1884)
STRANGE PARTICLES
*See also K*RESONANCES*
KAONS
STRANGE PARTICLES/WEAK INTERACTIONS
Unitary unified field theories, 3:27309
STRATIFIED CHARGE ENGINES/FUEL INJECTION SYSTEMS
Theoretical model for two-phase fuel injection in stratified charge engines, 3:26588 (UCRL-79534)
STREAMS/POLLUTION
Environmental effect of mercury, with particular attention to the Monte Amiata Zone, 3:26885 (ORNL-tr-4479)
STRING MODELS/HADRONS
Strings, vortices, and gauge fields, 3:27211
STRING MODELS/RIEMANN SPACE
Generalization of the quark-confining string, 3:27157
STRONG INTERACTIONS
See also HADRON-HADRON INTERACTIONS
STRONG INTERACTIONS/COUPLING CONSTANTS
Currents, quarks, and gluons, 3:27162
STRONG INTERACTIONS/QUANTUM ELECTRODYNAMICS
Impact of quantum electrodynamics, 3:27255 (SLAC-PUB-1699)
STRONG INTERACTIONS/QUANTUM FIELD THEORY
Hadrons (usual and newly discovered) in gauge theories a dream, 3:27213
STRONTIUM 85/ENVIRONMENTAL TRANSPORT
Radionuclide transport (Hanford terrestrial ecosystems), 3:25948 (PNL-2253)
STRONTIUM 86/ISOTOPE RATIO
Iotopic evidence for local derivation of strontium in deep-seated, fracture-filling calcite from granitic rocks in drill hole GT-2, Los Alamos Scientific Laboratory Dry Hot Rock Program, 3:26103
STRONTIUM 87/ISOTOPE RATIO
Iotopic evidence for local derivation of strontium in deep-seated, fracture-filling calcite from granitic rocks in drill hole GT-2, Los Alamos Scientific Laboratory Dry Hot Rock Program, 3:26103
STRONTIUM 90/ENVIRONMENTAL TRANSPORT
Ecology of Hanford 200 Area and 1976 radionuclide inventory, 3:25944 (PNL-2253)
Radionuclide transport (Hanford terrestrial ecosystems), 3:25948 (PNL-2253)
STRONTIUM 90/LEACHING
Leaching behavior of strontium-90 in cement composites, 3:25942
STRONTIUM 90/RADIATION MONITORING
Revegetation of a waste disposal site in the 200 areas of the Hanford Reservation, 3:26908 (PNL-2454)
STRONTIUM OXIDES/ENDOR
Single-particle properties of systems undergoing structural phase transitions, 3:26638
STRONTIUM OXIDES/PHYSICAL RADIATION EFFECTS
Electron-nuclear double resonance of V/sub OD/ defects in SrO, 3:26631
Single-particle properties of systems undergoing structural phase transitions, 3:26638
STRONTIUM OXIDES/V CENTERS
Electron-nuclear double resonance of V/sub OD/ defects in SrO, 3:26631
Single-particle properties of systems undergoing structural phase transitions, 3:26638
STRUCTURES (MECHANICS)
See MECHANICAL STRUCTURES
STUDS
See FASTENERS
SU-2 GROUPS/SYMMETRY BREAKING
Possible supersymmetry breaking by pseudoparticles, 3:27244
SUBBITUMINOUS COAL/COMBUSTION
Composition and variation of pulverized fuel ash obtained from the combustion of sub-bituminous coals, New Zealand, 3:25673
SUBBITUMINOUS COAL/PYROLYSIS
Preparation of a coal conversion systems technical data book. Project 8979 quarterly report, May 1-July 31, 1977, 3:25633 (FE-2286-20)
SUBMARINES
Submarine transports offshore workers below the surface, 3:25761
SUDDEN IONOSPHERIC DISTURBANCE/TABLES
Solar-geophysical data number 396, August 1977. Part I. (Prompt Reports). Data for July 1977-June 1977, 3:27027 (PB-273617)
SULFATES/CHEMICAL COMPOSITION
Chemical composition of sulfate as a function of particle size in New York summer aerosol, 3:26872 (BNL-23672)
SULFOCYANIDES
See THIOCYANATES
SULFUR/CHEMICAL ANALYSIS
Environmental assessment of the HYGAS Process. Project No. 9025 monthly progress report, August 1-August 31, 1977, 3:25637 (FE-2433-18)
SULFUR/ENVIRONMENTAL TRANSPORT
Corrections and revisions to the FORTRAN IV version of the Wisconsin Hydrologic Transport Model, 3:27003 (ORNL/NSF/EATC-29)
SULFUR/GASIFICATION
Environmental assessment of the HYGAS Process. Project No. 9025 monthly progress report, July 1-July 31, 1977, 3:25636 (FE-2433-17)
SULFUR/REMOVAL
Catalyst development for coal liquefaction. Annual report, July 1, 1976-June 30, 1977, 3:25657 (FE-2335-13)
Clean solid and liquid fuels from coal. Quarterly progress report, July-September 1977, 3:25665 (TID-28167)
SULFUR 32 REACTIONS/FUSION REACTIONS
Energy dependence of $^{32}S + {}^{24}Mg$ fusion cross sections (100 to 200 MeV), 3:27341 (ANL-77-60)
SULFUR COMPOUNDS/CATALYTIC EFFECTS
Distinctive catalysis by phosphonium and sulfonium compounds in low-temperature liquid-phase hydrocarbon oxidation, 3:26688
SULFUR COMPOUNDS/SYNTHESIS
Laser synthetic chemistry (SF_5NF_2), 3:26692 (LA-UR-77-2790)
SULFUR DIOXIDE/ADSORPTION
Removal of sulfur dioxide from gases using activated carbon at elevated temperatures, 3:26668
SULFUR DIOXIDE/ECOLOGICAL CONCENTRATION
Analysis of random errors in air-quality measurements. Final report, 3:26881 (PB-270555)
SULFUR DIOXIDE/REMOVAL
Application of scrubbing systems to low sulfur/alkaline ash coals. Final report, 3:25678 (EPRI-FP-595)
Catalytic oxidation of calcium sulfite during removal of SO_2 from flue gases by the limestone method, 3:26787

Summary of the effects of important chemical variables upon the performance of lime/limestone wet scrubbing systems. Interim report, 3:25679 (EPRI-FP-639)
Survey of the application of flue gas desulfurization technology in the industrial sector, 3:26786 (PB-270548)
SULFUR FLUORIDES/DISSOCIATION
Rotational-vibrational transition moments in excited states of spherical-top molecules, 3:27052
SULFUR FLUORIDES/ENERGY-LEVEL TRANSITIONS
Rotational-vibrational transition moments in excited states of spherical-top molecules, 3:27052
SULFUR HYDRIDES
See HYDROGEN SULFIDES
SULFUR IONS/COLLISIONS
Role of K-shell vacancies in determining charge-state fractions for heavy ions emerging from solids, 3:27077
SULFUR OXIDES/POINT POLLUTANT SOURCES
Source assessment: pressed and blown glass manufacturing plants. Final task report Sep 75-Jan 77, 3:26882 (PB-273788)
SULFUR OXIDES/REMOVAL
Studies on nitrogen oxides removal from flue gas (No. 2), 3:26196
SUN/MAGNETIC FIELDS
Comparison of H-alpha synoptic charts with the large-scale solar magnetic field as observed at Stanford. Scientific technical report, 3:27025 (AD-A-043336)
Solar-geophysical data number 396, August 1977. Part I. (Prompt Reports). Data for July 1977-June 1977, 3:27027 (PB-273617)
SUN/MAPS
Solar-geo/physical data number 396, August 1977. Part II (comprehensive reports). Data for February 1977-January 1977 and miscellanea, 3:27028 (PB-273618)
SUN/RESEARCH PROGRAMS
Aerospace Corporation space sciences program: report to COSPAR CY 1976. Interim report, 3:27026 (AD-A-043372)
SUPER PHENIX REACTOR/FUEL PINS
Advanced mixed oxide fuel element for fast reactors, 3:26304
SUPERCONDUCTING COILS/PERFORMANCE
Application of a two superconducting ellipsoidal coil system without external magnetic field as an inductive energy storage (Part 1), 3:27651 (LA-tr-78-12)
SUPERCONDUCTING COILS/SUPPORTS
Lateral support structure for constant tension D-shaped coils in tokamak fusion devices, 3:27643 (WFPS-TME-063)
SUPERCONDUCTING DEVICES
See also SUPERCONDUCTING FILMS
SUPERCONDUCTING MAGNETS
SUPERCONDUCTING DEVICES/BIBLIOGRAPHIES
Superconducting devices and materials. A literature survey issued quarterly, July-September 1977. Issue No. 77-03, 3:26710 (NP-23061)
SUPERCONDUCTING FILMS/VACUUM COATING
Oscillations of properties of thin superconducting films with varying coating thickness, 3:26624
SUPERCONDUCTING MAGNETS
See also MAGNETIC ENERGY STORAGE
SUPERCONDUCTING MAGNETS/COST
Trade study analysis for TNS tokamaks, 3:27642 (WFPS-TME-056)
SUPERCONDUCTING MAGNETS/DESIGN
Design study of superconducting poloidal magnets for tokamak fusion power reactor, 3:27633 (JAERI-M-6802)
Design study of superconducting toroidal field magnet for tokamak fusion power reactor, 3:27634 (JAERI-M-6921)
SPMS-1 superconducting magnet system for an MHD generator, 3:26539 (JPRS-69811)
Structural analysis methods and design solutions for OHMIC heating solenoids, 3:27641 (WFPS-TME-045)
Toroidal field magnet system utilizing normal metal trimming coils, 3:27640 (UWFDM-225)
SUPERCONDUCTING MAGNETS/FABRICATION
Selection of the superconducting current-carrying element for the "T-10M" installation, 3:27645 (LA-tr-78-10)
SUPERCONDUCTING MAGNETS/PERFORMANCE
Trade study analysis for TNS tokamaks, 3:27642 (WFPS-TME-056)
SUPERCONDUCTING MAGNETS/TEST FACILITIES
Large coil test facility conceptual design report, 3:27636 (ORNL/TM-6032)
SUPERCONDUCTIVITY/CRITICAL FIELD
Theory of destruction of superconductivity by optical pumping, 3:27405
SUPERCONDUCTIVITY/OPTICAL PUMPING
Theory of destruction of superconductivity by optical pumping, 3:27405
SUPERCONDUCTIVITY/RESEARCH PROGRAMS
Cryogenics program, 3:26709 (LA-6807-PR)
SUPERCONDUCTORS
See also TTF-TCNQ
TYPE-II SUPERCONDUCTORS
SUPERCONDUCTORS/BIBLIOGRAPHIES
Superconducting devices and materials. A literature survey issued quarterly, July-September 1977. Issue No. 77-03, 3:26710 (NP-23061)
SUPERFLUIDITY/HYDRODYNAMICS
Hydrodynamics of Fermi superfluids, 3:27096
SUPERGRAVITY/GAUGE INVARIANCE
Superunified theories based on the geometry of local (super-) gauge invariance, 3:27273
SUPERHEATERS/MANUFACTURING
Manufacture of an experimental batch of convective heating surfaces for the Lithuanian district power station, 3:26183
SUPERNOVA REMNANTS/X-RAY SPECTRA
X-ray spectrum and structure of the Puppis a supernova remnant, 3:27030
SUPERSONIC FLOW/MATHEMATICAL MODELS
Accelerated iterative calculation of transonic nacelle flowfields, 3:27091
SUPERTANKERS
See TANKER SHIPS
SURFACE BARRIER DETECTORS/DESIGN
Jupiter energetic particle experiment ESAD proton sensor design, 3:26818 (LA-7009-MS)
SURFACE BARRIER DETECTORS/RESOLUTION
Jupiter energetic particle experiment ESAD proton sensor design, 3:26818 (LA-7009-MS)
SURFACE MINING
See also OIL SHALE MINING
SURFACE MINING/BIBLIOGRAPHIES
Strip mining. Volume 2. 1976-October 1977 (citations from the NTIS data base). Report for 1976-Oct 77, 3:26919 (NTIS/PS-77/0951)
SURFACE MINING/ENVIRONMENTAL IMPACTS
Strip mining. Volume 2. 1976-October 1977 (citations from the NTIS data base). Report for 1976-Oct 77, 3:26919 (NTIS/PS-77/0951)
SURFACE MINING/LAND RECLAMATION
Strip mining. Volume I. 1964-1975 (citations from the NTIS data base). Report for 1964-75, 3:26918 (NTIS/PS-77/0950)
Strip mining. Volume 2. 1976-October 1977 (citations from the NTIS data base). Report for 1976-Oct 77, 3:26919 (NTIS/PS-77/0951)
SURFACE MINING/REGULATIONS
Application of Landsat-2 data to the implementation and enforcement of the Pennsylvania Surface Mining Conservation and Reclamation Act. Final report, March 1975-May 1977, 3:26921 (E-77-10184)
SURFACE MINING/VENTILATION
Movements of air flows in the working zones of excavators in open-pit mines, 3:25704 (LA-tr-78-6)
SURFACE WATERS
See also COASTAL WATERS
LAKES
SEAS
STREAMS
SURFACE WATERS/CHEMICAL ANALYSIS
Automation of the national water quality laboratories, U.S. Geological Survey 2: design concepts for achievement of automation objectives (Computer systems), 3:27017 (UCRL-52295(Pt.2))
SURFACE WATERS/MINERAL CYCLING
Corrections and revisions to the FORTRAN IV version of the Wisconsin Hydrologic Transport Model, 3:27003 (ORNL/NSF/EATC-29)
SURFACE WATERS/WATER QUALITY
Automation of the national water quality laboratories, U.S. Geological Survey 2: design concepts for achievement of automation objectives (Computer systems), 3:27017 (UCRL-52295(Pt.2))
SUSPENSIONS (FUEL)
See FUEL SLURRIES
SWEDEN/NUCLEAR POWER
Swedish nuclear power industry. A survey, 3:26335
SWIMMING POOLS/HEAT LOSSES
Swimming pool heating by solar energy, 3:26056
SWIMMING POOLS/SOLAR WATER HEATING
Swimming pool heating by solar energy, 3:26056
SWITCHES/DESIGN
Dynamic behavior of a resistive transfer circuit with a superconducting switch, 3:27647 (EUR-5602)
SWITCHES/PERFORMANCE
Results of research into superconducting switches with high specific switching capacity, 3:27650 (LA-tr-78-13)
Technology and characteristics of breakdown and plasma in shock tube arrangements, 3:27489 (EUR-5602)
SWITZERLAND/LMFBR TYPE REACTORS
Development of advanced fuels in Switzerland (LMFBR), 3:26298

SWITZERLAND/WASTE MANAGEMENT
Where does the garbage go, 3:26575 (DOE-tr-26)
SWITZERLAND/WASTE PROCESSING PLANTS
Where does the garbage go, 3:26575 (DOE-tr-26)
SYMMETRY BREAKING/MATHEMATICAL MODELS
Simple mathematical models of symmetry breaking. Application to particle physics, 3:27249
SYMMETRY BREAKING/PARTICLE PRODUCTION
Dynamical symmetry breakdown, 3:27248
SYMMETRY GROUPS
Super-gauge groups, 3:27204
Symmetries gained and lost, 3:27424
SYNTHANE PROCESS/COMPARATIVE EVALUATIONS
Quarterly technical progress report, October-December 1977, 3:25631 (FE-2240-79)
SYNTHESIS GAS/DEMONSTRATION PLANTS
Fossil energy demonstration plants, 3:25642 (TID-28182)
SYNTHESIS GAS/DESULFURIZATION
Advanced technology fuel cell program. Interim report, 3:26543 (EPRI-EM-576)
SYNTHETIC FUELS
See also REFUSE DERIVED FUELS
Technology evaluation of Army-scale waste-to-energy systems, 3:25973 (AD-A-042578)
SYNTHETIC FUELS/AIR POLLUTION ABATEMENT
Advanced fossil fuel and the environment: an executive report, 3:26192 (EPA-600/9-77-013)
SYNTHOIL PROCESS
Enthalpy measurement of coal-derived liquids. Quarterly technical progress report, October-December 1977, 3:25652 (FE-2035-10)
SYNTHOIL PROCESS/COAL LIQUIDS
Spectral studies of coal-derived liquids, 3:25667 (PERC/RI-77/14)
SYNTHOIL PROCESS/MULTIPHASE FLOW
Three-phase flow characteristics of cylindrical vessels, 3:25662 (ORNL/MIT-257)

T

TANDEM ACCELERATORS
See VAN DE GRAAFF ACCELERATORS
TANKER SHIPS
330000 m3 Verolme LNG carrier, 3:25877
Review of current LNG ship technology and an attempt to rationalize, 3:25869
TANKER SHIPS/BIBLIOGRAPHIES
Supertankers and superports (citations from the NTIS data base). Report for 1964-July 1977 (Construction; operation), 3:25807 (NTIS/PS-77/0700)
Supertankers and superports (citations from the Engineering Index data base). Report for 1970-July 1977, 3:25808 (NTIS/PS-77/0701)
TANKER SHIPS/CONSTRUCTION
Transfer system of completed spherical tank for LNG carrier, 3:25868
TANKER SHIPS/DESIGN
New Invar membrane containment system for construction of LNG carriers, 3:25880
Spherical LNG tanks on continuous cylindrical skirts: a shipbuilder and licenser's experience, 3:25879
TANKER SHIPS/PERFORMANCE
Experiences in the commissioning of liquid natural gas carriers, 3:25875
Operational experience with LNG ships, 3:25874
Twelve years operating experience with Methane Princess and Methane Progress, 3:25876
TANKER SHIPS/PUMPING
Noise of cargo oil pumps and effect on accommodation of large tanker, 3:25809
TANKER SHIPS/TESTING
Prototype tank test of semi-membrane LNG carrier, 3:25878
TANKER SHIPS/THERMAL INSULATION
New Invar membrane containment system for construction of LNG carriers, 3:25880
Studies on defect occurrence of LPG tank insulation executed in winter, 3:25866
TANKS/LEVELS
Displacement technique for calibration for special nuclear material tankage volumes, 3:26840 (RFP-2627)
TANKS/SENSIBLE HEAT STORAGE
Passive technique for enhancing thermal stratification in liquid storage tanks, 3:26080 (COO/4511-2)
Stratified versus well-mixed sensible heat storage in a solar space heating application, 3:26079 (COO/4511-2)
TANKS/SHIELDED METAL-ARC WELDING
Application of automatic gas shield arc welding to the vertical butt joint of an oil storage tank shell, 3:25822
TANKS/THERMAL INSULATION
Insulation system for low temperature service double wall tank, 3:25885
TANTALUM/ION EXCHANGE
Cation exchange of 53 elements in nitric acid, 3:26665 (LA-7083)
TANTALUM/THERMAL EXPANSION
Experimental study of the thermal expansion of various construction materials. Tantalum and tantalum-tungsten TV-10 alloy, 3:26617
Features of the expansion of condensed substances acted on by high-power shock waves, 3:26613
TANTALUM 181 TARGET/NEUTRON REACTIONS
Coherent dissociation of neutrons on nuclei at 100-300 GeV/c, 3:27123
Cross sections for (n,2n) and (n,3n) reactions above 14 MeV, 3:27353
TANTALUM 181 TARGET/PHOTONUCLEAR REACTIONS
Pre-equilibrium particle decay in the photonuclear reactions, 3:27327
psi and excess leptons in photoproduction, 3:27099 (SLAC-PUB-1728)
TANTALUM 181 TARGET/PION MINUS REACTIONS
Energetic charged particle yields induced by pions on complex nuclei (π^{+-} on ^{27}Al, ^{62}Ni, ^{181}Ta, 100 and 220 MeV: cross sections), 3:27360 (ANL-77-60)
Study of pion-absorption mechanisms in ^{4}He and other nuclei, 3:27323
TANTALUM 181 TARGET/PION PLUS REACTIONS
Energetic charged particle yields induced by pions on complex nuclei (π^{+-} on ^{27}Al, ^{62}Ni, ^{181}Ta, 100 and 220 MeV: cross sections), 3:27360 (ANL-77-60)
Study of pion-absorption mechanisms in ^{4}He and other nuclei, 3:27323
TANTALUM ALLOYS/THERMAL EXPANSION
Experimental study of the thermal expansion of various construction materials. Tantalum and tantalum-tungsten TV-10 alloy, 3:26617
TANTALUM CARBIDES/ELECTRIC CONDUCTIVITY
Thermal and electrical conductivity of tantalum carbide at high temperatures (1500-3000°K), 3:26616
TANTALUM CARBIDES/THERMAL CONDUCTIVITY
Thermal and electrical conductivity of tantalum carbide at high temperatures (1500-3000°K), 3:26616
TAR SANDS
See OIL SANDS
TARGETS/COOLING
Target cooling (Bates Linac), 3:27314 (ORO-4043-37)
TARGETS/LASER RADIATION
Non-linear interaction of intense CO_2 radiation with dense plasma, 3:27686
TATB
(1,3,5-Triamino-2,4,6-trinitrobenzene.)
TATB/SYNTHESIS
Researching an alternate synthesis of triaminotrinitrobenzene, 3:26683 (UCRL-13808)
TAU NEUTRINO/MASS
Comments on the tau heavy lepton, 3:27110 (SLAC-PUB-1991)
TAU PARTICLE/COUPLING
Comments on the tau heavy lepton, 3:27110 (SLAC-PUB-1991)
TAU PARTICLE/DECAY
Comments on the tau heavy lepton, 3:27110 (SLAC-PUB-1991)
Evidence for, and properties of, the new charged heavy lepton, 3:27109 (SLAC-PUB-1923)
TAU PARTICLE/HEAVY LEPTONS
Comments on the tau heavy lepton, 3:27110 (SLAC-PUB-1991)
TAU PARTICLE/LEPTONIC DECAY
Evidence for, and properties of, the new charged heavy lepton, 3:27109 (SLAC-PUB-1923)
Evidence for, and properties of the tau lepton (Cross sections), 3:27112 (SLAC-PUB-2055)
Experimental limits on heavy lepton production by neutrinos (Mixing angle limits), 3:27106 (BNL-23513)
TAU PARTICLE/MASS
Comments on the tau heavy lepton, 3:27110 (SLAC-PUB-1991)
Evidence for, and properties of, the new charged heavy lepton, 3:27109 (SLAC-PUB-1923)
TAU PARTICLE/PARTICLE PROPERTIES
Evidence for, and properties of, the new charged heavy lepton, 3:27109 (SLAC-PUB-1923)
Evidence for, and properties of the tau lepton (Cross sections), 3:27112 (SLAC-PUB-2055)
TECHNETIUM/ION EXCHANGE
Cation exchange of 53 elements in nitric acid, 3:26665 (LA-7083)
TECHNETIUM 99/ENVIRONMENTAL TRANSPORT
Radionuclide transport (Hanford terrestrial ecosystems), 3:25948 (PNL-2253)

TECHNETIUM FLUORIDES/ENTROPY
Heat capacity, entropy, and Gibbs energy of technetium hexafluoride between 2.23 and 350 K; magnetic anomaly at 3.12 K; mean β energy of ^{99}Tc, 3:26649
TECHNETIUM FLUORIDES/FREE ENERGY
Heat capacity, entropy, and Gibbs energy of technetium hexafluoride between 2.23 and 350 K; magnetic anomaly at 3.12 K; mean β energy of ^{99}Tc, 3:26649
TECHNETIUM FLUORIDES/SPECIFIC HEAT
Heat capacity, entropy, and Gibbs energy of technetium hexafluoride between 2.23 and 350 K; magnetic anomaly at 3.12 K; mean β energy of ^{99}Tc, 3:26649
TECHNOLOGY ASSESSMENT/SIMULATION
ETA-MACRO: a model of energy-economy interactions (Simulates market economy through dynamic nonlinear optimization process), 3:26497 (EPRI-EA-592)
TECHNOLOGY TRANSFER/FEASIBILITY STUDIES
ESCOE engineering program. Quarterly report, September 1-November 30, 1977, 3:25638 (FE-2468-18)
TELEVISION/DESIGN
Development and use of a TV system for viewing flames, 3:26782
TELLURIUM/ION EXCHANGE
Cation exchange of 53 elements in nitric acid, 3:26665 (LA-7083)
TELLURIUM/QUANTITATIVE CHEMICAL ANALYSIS
Fate of trace and minor constituents of coal during gasification. Final task report, 3:25641 (PB-270913)
TELLURIUM 128 TARGET/PROTON REACTIONS
Anomalous optical-model potential for sub-Coulomb protons for $89 < A < 130$, 3:27361
TELLURIUM 130 TARGET/PROTON REACTIONS
Anomalous optical-model potential for sub-Coulomb protons for $89 < A < 130$, 3:27361
TEMPERATURE CONTROL/ELECTRONIC CIRCUITS
Phase-insensitive detectors for ac resistance bridges with application to temperature control systems, 3:26843 (Y/DA-7468)
TEMPERATURE MEASUREMENT/ULTRALOW TEMPERATURE
Regulator for controlling liquid helium bath near 4.2 K, 3:26711
TERBIUM COMPOUNDS/CRYSTAL FIELD
Sublattice magnetization in TbD_2: crystalline electric field effects, 3:26637
TERBIUM COMPOUNDS/EXCITED STATES
Rare earth vapor laser studies, 3:27680 (UCRL-79364)
TERBIUM COMPOUNDS/KNIGHT SHIFT
Systematics in the Knight shift of rare-earth monopnictides, 3:26600
TERBIUM COMPOUNDS/MAGNETIC SUSCEPTIBILITY
Sublattice magnetization in TbD_2: crystalline electric field effects, 3:26637
TERMINAL FACILITIES
See also LIQUEFIED NATURAL GAS STORAGE FACILITIES
TERMINAL FACILITIES/LEGAL ASPECTS
Some legal aspects of a LNG terminal establishment and operation in France, 3:25890
TERRESTRIAL ECOSYSTEMS/MATHEMATICAL MODELS
Management models, 3:25950 (PNL-2253)
TERRESTRIAL ECOSYSTEMS/POLLUTION
Ecological consequences of nuclear testing, 3:26907 (TID-26712)
TERRESTRIAL ECOSYSTEMS/RADIONUCLIDE MIGRATION
Initial synthesis of area 13 ^{239}Pu data and other statistical analyses (^{239}Pu and ^{240}Pu distribution in soil and biological samples from Nevada Test Site), 3:26912 (NVO-171)
Radionuclide transport (Hanford terrestrial ecosystems), 3:25948 (PNL-2253)
TERRESTRIAL ECOSYSTEMS/RESEARCH PROGRAMS
Ecology of the 200 Area plateau waste management environs: a status report, 3:25943 (PNL-2253)
Future research needs, 3:25952 (PNL-2253)
TEST FACILITIES
See also TONOPAH TEST RANGE
TEST FACILITIES/DESIGN
Large coil test facility conceptual design report, 3:27636 (ORNL/TM-6032)
TEST FACILITIES/OPERATION
Coal liquefaction pilot plant, Cresap, West Virginia. Monthly technical progress report, November 1977, 3:25650 (FE-1517-58)
TETRAHYDRONAPHTHALENE
See TETRALIN
TETRALIN/CHEMICAL REACTIONS
Homogeneous catalytic hydrocracking processes for conversion of coal to liquid fuels: basic and exploratory research. Quarterly report No. 7, May 1, 1977-July 31, 1977, 3:25653 (FE-2202-21)
TETRALIN/OXIDATION
Distinctive catalysis by phosphonium and sulfonium compounds in low-temperature liquid-phase hydrocarbon oxidation, 3:26688
TEXACO GASIFICATION PROCESS/CHEMICAL FEEDSTOCKS
Gasification of residual materials from coal liquefaction. Evaluation of SRC II vacuum flash drum bottoms as feedstock to the Texaco Coal Gasification Process, 3:25632 (FE-2247-9R)
TEXAS/DUSTS
Comparison of aerosol and momentum mixing in dust storms using fast-response instruments, 3:26866
TFR TOKAMAK/DATA ACQUISITION SYSTEMS
New developments of the data acquisition system of TFR, 3:27695 (EUR-5602)
TFR TOKAMAK/IMPURITIES
Oxygen gas injection during the current plateau of a TFR tokamak plasma, 3:27623
Plasma-wall interactions in the TFR machine, 3:27611 (EUR-CEA-FC-889)
TFR TOKAMAK/LIMITERS
Description of the fast moving limiter used with T.F.R., 3:27612 (EUR-CEA-FC-893)
TFR TOKAMAK/PLASMA INSTABILITY
Structure of low-frequency oscillations during the disruptive instability in the TFR tokamak, 3:27552
TFR TOKAMAK/X-RAY SPECTRA
Identification of Mo XV to Mo XXXIII in the soft X-ray spectrum of the TFR Tokamak, 3:27490 (EUR-CEA-FC-887)
TFTR REACTOR/CYCLOTRON INSTABILITY
Parametric dependence of the ion cyclotron instability in a two-energy-component system, 3:27545
TFTR REACTOR/IMPURITIES
Calculations of impurity radiation and its effects on tokamak experiments, 3:27627
TFTR REACTOR/ION WAVES
Parametric dependence of the ion cyclotron instability in a two-energy-component system, 3:27545
TFTR REACTOR/NEUTRAL ATOM BEAM INJECTION
Magnetics design for ripple-assisted beam injection into the ISX-B and TFTR Tokamaks, 3:27592 (CONF-771029-203)
Parametric dependence of the ion cyclotron instability in a two-energy-component system, 3:27545
TFTR REACTOR/PLASMA DIAGNOSTICS
TFTR diagnostic development (9C). First quarterly report, October-December 1977, 3:27470 (TID-27931)
THALLIUM/ION EXCHANGE
Cation exchange of 53 elements in nitric acid, 3:26665 (LA-7083)
THALLIUM 186/BETA-PLUS DECAY
Shape coexistence in ^{186}Hg and the decay of ^{186}Tl, 3:27370
THERMAL CONDUCTION
(Heat transfer by conduction.)
THERMAL CONDUCTION/NUMERICAL SOLUTION
SIMPLE code (Solution of equations of inviscid compressible hydrodynamics and simple heat conduction), 3:26770 (UCID-17715)
THERMAL DECOMPOSITION
See PYROLYSIS
THERMAL ENERGY STORAGE EQUIPMENT/HEAT EXCHANGERS
Direct contact heat exchange for latent heat-of-fusion energy storage systems, 3:26483 (SAND-77-8665)
THERMAL ENERGY STORAGE EQUIPMENT/PERFORMANCE TESTING
Evaluation of eutectic fluoride thermal energy storage unit compatibility. II. Test procedures and post-test evaluation results. Interim technical report, October 1975-June 1976, 3:26482 (AD-A-042234)
THERMAL INSULATION/PRODUCTION
Studies on defect occurrence of LPG tank insulation executed in winter (Polyurethane foam), 3:25866
THERMAL POLLUTION
(Environmental temperature rise due to waste heat disposal)
THERMAL POLLUTION/MATHEMATICAL MODELS
Phenomenological models for prediction of water temperatures due to thermal-electric power plant heated discharges. Final report, 3:26935 (PB-273468)
THERMAL POWER PLANTS/AIR HEATERS
Air preheater made of corrugated tubes, 3:26168
THERMAL POWER PLANTS/BOILER FUEL
Design development and experience of operation of a high-temperature residual oil preheater, 3:26185
THERMAL POWER PLANTS/CLEANING
Technology of acoustic pipe cleaning at power engineering plants, 3:26182
THERMAL POWER PLANTS/COOLING TOWERS
Application of statistical methods to obtain analytical characteristics of air condensing installations, 3:26138
Influence of method of cooling tower operation on plume length, 3:26137
THERMAL POWER PLANTS/ELECTRIC CABLES
Flexible couplings between power plant main buildings and 500 kV open distribution units using lateral loops, 3:26201

THERMAL POWER PLANTS/FEEDWATER HEATERS
High pressure single-housing collector preheaters for the 800 MW power unit, 3:26159
THERMAL POWER PLANTS/FLUE GAS
Studies on nitrogen oxides removal from flue gas (No. 2), 3:26196
THERMAL POWER PLANTS/GAS TURBINES
Kawasaki PU200 gas turbine power generator, 3:26180
THERMAL POWER PLANTS/HEAT EXCHANGERS
Manufacture of an experimental batch of convective heating surfaces for the Lithuanian district power station, 3:26183
THERMAL POWER PLANTS/RELIABILITY
Reliability indices of power units following their enlargement, 3:26128
THERMAL POWER PLANTS/SCALING
Stabilization treatment of return cooling water with phosphonates, 3:26158
THERMAL POWER PLANTS/SCRUBBERS
Studies on nitrogen oxides removal from flue gas (No. 2), 3:26196
THERMAL POWER PLANTS/SIZE
Reliability indices of power units following their enlargement, 3:26128
THERMAL POWER PLANTS/SUPERHEATERS
Manufacture of an experimental batch of convective heating surfaces for the Lithuanian district power station, 3:26183
THERMAL POWER PLANTS/WATER REQUIREMENTS
Nationwide assessment of water quantity impacts of the National Energy Plan. Volume I. Summary and conclusions, 3:26932 (ORNL/TM-6098)
THERMAL SHIELDS/DESIGN
Rotation-symmetrical container with insulating cover (Patent), 3:26366
THERMAL SPRINGS
See also HOT SPRINGS
THERMAL SPRINGS/GEOTHERMOMETRY
Attempted geothermometric determination of maxima subsurface water temperatures of main hydrothermic areas of Languedoc-Roussillon and Pyrenees-Orientales, 3:26101
Use of geothermometer models in the exploration for a hydrogeothermal resource, 3:26097
THERMAL SPRINGS/POLLUTION
Environmental effect of mercury, with particular attention to the Monte Amiata Zone, 3:26885 (ORNL-tr-4479)
THERMAL SPRINGS/TEMPERATURE MEASUREMENT
Use of geothermometer models in the exploration for a hydrogeothermal resource, 3:26097
THERMAL WATERS/CHEMICAL COMPOSITION
Chemical components of hot springs in Nagano Prefecture, 3:26102
THERMAL WATERS/ROCK-FLUID INTERACTIONS
Transport phenomena in hydrothermal systems: cooling plutons, 3:26084
THERMIONIC CONVERTERS/ELECTRICAL PROPERTIES
Volt-ampere characteristics of thermionic converters in the diffusion regime with Coulomb collisions, 3:26541
THERMOCOUPLES/FAILURE MODE ANALYSIS
Failure of the thermocouple assembly from the HYGAS coal pretreatment vessel: failure analysis report, 3:25621 (ANL/MSD/FE-77-6R)
THERMOELECTRIC GENERATORS/RESEARCH PROGRAMS
Multi-hundred watt radioisotope thermoelectric generator program. Annual report, 1976-1977. Final report, 3:25956 (GESP-7134)
THERMOLUMINESCENT DOSEMETERS/CALIBRATION
Gamma-ray dosimetry errors with TLDs, 3:26827 (UCRL-80183)
Neutron dose monitoring using a multiple lithium fluoride TLD badge, 3:26462
THERMOLUMINESCENT DOSEMETERS/PERFORMANCE
Hanford critical radiation dosimeter, 3:26826 (PNL-2276)
THERMOLUMINESCENT DOSEMETERS/SENSITIVITY
Gamma-ray dosimetry errors with TLDs, 3:26827 (UCRL-80183)
Photon and beta response of a new thermoluminescent dosimeter badge, 3:26824 (LA-UR-77-3001)
THERMONUCLEAR DEVICES
See also ASTRON
BASEBALL DEVICES
ORMAK DEVICES
STELLARATORS
TOKAMAK DEVICES
THERMONUCLEAR DEVICES/DATA ACQUISITION SYSTEMS
Command interpreter for the Padua data acquisition system, 3:27693 (EUR-5602)
THERMONUCLEAR DEVICES/VACUUM SYSTEMS
Effect of vacuum conditions on plasma production and confinement, 3:27698 (EUR-5602)
THERMONUCLEAR FUELS
Conditions for a boron fusion reactor in the MeV range, 3:27662
THERMONUCLEAR FUELS/COMPRESSION
Space charge limited current flow between concentric spheres at potentials up to 15 MV, 3:27684
THERMONUCLEAR FUELS/COMPUTER CALCULATIONS
Laser fusion targets, 3:27675 (UCRL-52000-77-8)
THERMONUCLEAR FUELS/DESIGN
Laser fusion targets, 3:27675 (UCRL-52000-77-8)
THERMONUCLEAR FUELS/IMPLOSIONS
Ablation driven thermonuclear implosion targets of high efficiency, 3:27687
THERMONUCLEAR FUELS/LASER IMPLOSIONS
Increa e of thermonuclear field on fast implosion of cold shell targets by means on nonlinear interaction of laser radiation with plasma, 3:27691
Investigation of compression of hollow microspheres irradiated by a laser, 3:27689
Stationary model of the 'corona' of spherical laser targets, 3:27690
THERMONUCLEAR FUELS/SHAPE
Ablation driven thermonuclear implosion targets of high efficiency, 3:27687
THERMONUCLEAR FUELS/SURFACE COATING
Plasma polymerization coating of D-T filled glass shells for laser fusion targets, 3:27682 (UCRL-80162)
THERMONUCLEAR IGNITION/MULTIPLICATION FACTORS
Ignition parameter Tntau and the energy multiplication factor k for fusioning plasmas, 3:27523
THERMONUCLEAR REACTIONS/MULTIPLICATION FACTORS
Ignition parameter Tntau and the energy multiplication factor k for fusioning plasmas, 3:27523
THERMONUCLEAR REACTOR WALLS
See also FIRST WALL
THERMONUCLEAR REACTOR WALLS/NEUTRON FLUX
Poloidal distributions of radiation heating and 14 MeV neutron flux at first wall, 3:27697 (EUR-5602)
THERMONUCLEAR REACTOR WALLS/RADIATION HEATING
Poloidal distributions of radiation heating and 14 MeV neutron flux at first wall, 3:27697 (EUR-5602)
THERMONUCLEAR REACTORS
(For use in cases where certain aspects of either hypothetical or real thermonuclear reactors are discussed.)
See also D-T REACTORS
LASER FUSION REACTORS
MAGNETIC MIRROR TYPE REACTORS
REFERENCE THETA PINCH REACTOR
THERMONUCLEAR REACTOR WALLS
TOKAMAK TYPE REACTORS
THERMONUCLEAR REACTORS/IMPLOSIONS
Stabilized imploding liner fusion systems, 3:27600
THERMONUCLEAR REACTORS/LINERS
Energetic aspects of fast-fusion reactors with dense liners of medium velocities (10 to 100 kms^{-1}), 3:27704
THERMONUCLEAR REACTORS/MAGNET COILS
Power loss problems in EXTRAP coil systems, 3:27639 (TRITA-PFU-77-02)
THERMONUCLEAR REACTORS/MEETINGS
Proceedings of the 9. symposium on fusion technology, 3:27539 (EUR-5602)
THERMONUCLEAR REACTORS/PLASMA HEATING
Heating of toroidal plasmas, 3:27426 (CEA-CONF-3863)
THERMONUCLEAR REACTORS/RAYLEIGH-TAYLOR INSTABILITY
Low frequency instability of liquid liner implosions driven by multiple free pistons. Memorandum report, 3:27536 (AD-A-043284)
THERMONUCLEAR REACTORS/REACTOR FUELING
Improvements in or relating to fusion nuclear reactors (Patent), 3:27661
THERMONUCLEAR REACTORS/RESEARCH PROGRAMS
Survey of the U.S. magnetic fusion program, 3:27594 (EUR-5602)
THERMONUCLEAR REACTORS/REVIEWS
Summary of reactor systems, 3:27603
THERMONUCLEAR REACTORS/SPECIFICATIONS
Improvements in or relating to nuclear fusion reactors (Patent), 3:27599
THERMONUCLEAR WEAPONS
See NUCLEAR WEAPONS
THETA PINCH/BEAM INJECTION HEATING
Intense relativistic electron beam interaction with a cool theta pinch plasma, 3:27438
THETA PINCH/PLASMA MICROINSTABILITIES
Kinetic and numerical studies of microstability properties and anomalous transport in theta pinches, 3:27549
THIO COMPOUNDS
See ORGANIC SULFUR COMPOUNDS

THIOCYANATES/BIODEGRADATION
Bio-oxidation of aqueous cyanogens typical of Synthane gasifier by-product water. Progress report, September 1, 1977-November 30, 1977, 3:26947 (COO/4502-1)
THIOCYANATES/POTASSIUM COMPOUNDS
Bio-oxidation of aqueous cyanogens typical of Synthane gasifier by-product water. Progress report, September 1, 1977-November 30, 1977, 3:26947 (COO/4502-1)
THIOPHENE/CHEMICAL REACTIONS
Reactions of thiophene with radiolytically produced radicals. I. The hydroxyl radical, 3:26695
Reactions of thiophene with radiolytically produced radicals. II. The solvated electron and the hydrogen atom, 3:26696
THORIUM/ABUNDANCE
Rare earth and other trace elements in historic Azorean lavas, 3:27009
THORIUM/FUEL CYCLE
Conserving uranium without the fast breeder, 3:26506
THREE-BODY PROBLEM/MULTIPLE SCATTERING
Three-body approach to the single-scattering optical potential, 3:27394
THREE-BODY PROBLEM/OPTICAL MODELS
Three-body approach to the single-scattering optical potential, 3:27394
THTR-300 REACTOR/COOLING TOWERS
Dry cooling towers: the Schmehausen example, 3:26263
THTR-300 REACTOR/ECCS
Recommendations of the Reactor Safety Commission during its 121st meeting on February 16th, 1977. 300 MWe-THTR prototype nuclear power plant (THTR-300), 3:26467
THULIUM 169 TARGET/NEUTRON REACTIONS
Cross sections for (n,2n) and (n,3n) reactions above 14 MeV, 3:27353
THULIUM COMPOUNDS/KNIGHT SHIFT
Systematics in the Knight shift of rare-earth monopnictides, 3:26600
TICKS/SPERMATOZOA
Morphology and ultrastructure of spermatozoa of the ticks, 3:26980 (CONF-770504-)
TIDAL POWER/TECHNOLOGY ASSESSMENT
Marine engineering--the canadian challenge, 3:26124
TIN/ION EXCHANGE
Cation exchange of 53 elements in nitric acid, 3:26665 (LA-7083)
TIN/SOUND WAVES
Speed of ultrasound and thermophysical properties of the liquid metals of Sn, Cd, Bi and their binary alloys Cd-Bi and Sn-Bi, 3:26620
TIN/SUPERCONDUCTIVITY
Temperature fluctuations in freely suspended tin films at the superconducting transition, 3:26601
TIN/TEMPERATURE NOISE
Temperature fluctuations in freely suspended tin films at the superconducting transition, 3:26601
TIN 118 TARGET/PHOTONUCLEAR REACTIONS
Pre-equilibrium particle decay in the photonuclear reactions, 3:27327
TIN 119 TARGET/NEUTRON REACTIONS
Inclusive charged-particle production in neutron-nucleus collisions, 3:27121
TIN 119 TARGET/PROTON REACTIONS
Energy dependence of the ^{119}Sn(p,n)^{119}Sn(IAS) reaction, 3:27365
TIN ALLOYS/SOUND WAVES
Speed of ultrasound and thermophysical properties of the liquid metals of Sn, Cd, Bi and their binary alloys Cd-Bi and Sn-Bi, 3:26620
TIN ALLOYS/SUPERCONDUCTIVITY
Estimate of density-of-states changes with disorder in A-15 superconductors, 3:26602
TIN ISOTOPES/PROTON REACTIONS
Anomalous optical-model potential for sub-Coulomb protons for $89 < A < 130$, 3:27361
TIRES/RECYCLING
Cryogenic tire granulation, 3:26573
TISSUES/DEHYDRATION
Gross distortions in freeze-dried tissue preparations, 3:26956 (CONF-770504-)
TISSUES/ELECTRON MICROSCOPY
Three-hour rapid processing technique for electron microscopy, 3:26957 (CONF-770504-)
TISSUES/FREEZING
Gross distortions in freeze-dried tissue preparations, 3:26956 (CONF-770504-)
TISSUES/MORPHOLOGICAL CHANGES
Gross distortions in freeze-dried tissue preparations, 3:26956 (CONF-770504-)
TITANIUM/CREEP
Titanium and titanium alloy creep (a bibliography with abstracts). Report for 1964-September 1977, 3:26598 (NTIS/PS-77/0803)
TITANIUM/ION COLLISIONS
Role of K-shell vacancies in determining charge-state fractions for heavy ions emerging from solids, 3:27077
TITANIUM/ION EXCHANGE
Cation exchange of 53 elements in nitric acid, 3:26665 (LA-7083)
TITANIUM/PHOTOEMISSION
X-ray photoemission spectra of the valence bands of the 3d transition metals, Sc to Fe, 3:26608
TITANIUM 43/HIGH SPIN STATES
Gamma decay and lifetime measurements of the isomeric 19-/2 state in ^{43}Ti, 3:27347 (ANL-77-60)
TITANIUM 43/ISOMERIC TRANSITIONS
Gamma decay and lifetime measurements of the isomeric 19-/2 state in ^{43}Ti, 3:27347 (ANL-77-60)
TITANIUM 48 TARGET/NEUTRON REACTIONS
Coherent dissociation of neutrons on nuclei at 100-300 GeV/c, 3:27123
TITANIUM ALLOYS/CREEP
Titanium and titanium alloy creep (a bibliography with abstracts). Report for 1964-September 1977, 3:26598 (NTIS/PS-77/0803)
TITANIUM ALLOYS/HEAT TREATMENTS
Development of an aging integrator for uranium-0.75 weight percent titanium alloy part aging control, 3:26595 (Y-2101)
TNS REACTOR/DIVERTORS
Compact poloidal divertor reference design for TNS, 3:27621 (WFPS-TME-055)
TNS REACTOR/ELECTRIC GENERATORS
GAC-ANL TNS scoping studies. Status report for FY-77, October 1, 1976-September 30, 1977. Volume XI. TNS doublet tokamak ohmic-heating power supply study. LA-7053-MS, 3:27648 (GA-A-14614(Vol.11))
TNS REACTOR/LIMITERS
Small radius start-up of tokamak plasmas with a moving limiter, 3:27435 (ORNL/TM-6111)
TNS REACTOR/MAGNET COILS
Trade study analysis for TNS tokamaks, 3:27642 (WFPS-TME-056)
TNS REACTOR/MAGNETIC FIELD CONFIGURATIONS
ORNL TNS Program: plasma engineering considerations and innovations for a medium field tokamak fusion reactor, 3:27637 (ORNL/TM-6150)
TNS REACTOR/MAINTENANCE
GAC-ANL TNS scoping studies. Volume VIII. Maintainability studies. Status report for FY-77, October 1, 1976-September 30, 1977, 3:27701 (GA-A-14614(Vol.8))
TNS REACTOR/NEUTRAL ATOM BEAM INJECTION
Magnetics design for ripple-assisted beam injection into the ISX-B and TFTR Tokamaks, 3:27592 (CONF-771029-203)
TNS REACTOR/RELIABILITY
GAC-ANL TNS scoping studies. Volume VIII. Maintainability studies. Status report for FY-77, October 1, 1976-September 30, 1977, 3:27701 (GA-A-14614(Vol.8))
TNS REACTOR/REPAIR
GAC-ANL TNS scoping studies. Volume VIII. Maintainability studies. Status report for FY-77, October 1, 1976-September 30, 1977, 3:27701 (GA-A-14614(Vol.8))
TNS REACTOR/SPECIFICATIONS
ORNL TNS Program: plasma engineering considerations and innovations for a medium field tokamak fusion reactor, 3:27637 (ORNL/TM-6150)
TNS REACTOR/THERMONUCLEAR IGNITION
Small radius start-up of tokamak plasmas with a moving limiter, 3:27435 (ORNL/TM-6111)
TOBACCO PLANT
See NICOTIANA
TOKAMAK DEVICES
See also ALCATOR DEVICE
ATC DEVICES
JET TOKAMAK
JFT-2 TOKAMAK
JFT-2A TOKAMAK
PETULA TOKAMAK
PLT DEVICES
TFR TOKAMAK
TOKAMAK DEVICES/ACOUSTIC HEATING
Magnetoacoustic-heating experiments in tokamak T-4 plasma, 3:27451
TOKAMAK DEVICES/ALFVEN WAVES
Alfven short-wave excitation by high-energy ions in a tokamak, 3:27562 (IAE-2552)
Quasy - linear theory of satellite interaction of alphaparticles with Alfven waves in a tokamak, 3:27564 (IAE-2655)
To the nonlinear theory of alfven wave excitation in a tokamak, 3:27563 (IAE-2651)
TOKAMAK DEVICES/BEAM INJECTION HEATING
Cross-field injection, propagation, and energy deposition of intense ion beams with application to tokamak plasma heating, 3:27665

TOKAMAK DEVICES/CHARGED-PARTICLE TRANSPORT
Temperature gradient effect on impurity-ion transport, 3:27504 (JAERI-M-6965)
TOKAMAK DEVICES/DRIFT INSTABILITY
Drift-wave turbulence effects on magnetic structure and plasma transport in tokamaks, 3:27513
TOKAMAK DEVICES/ELECTRIC CURRENTS
Effect of current peaking on non-circular uniaxial tokamak equilibria, 3:27520
TOKAMAK DEVICES/ELECTRIC DISCHARGES
High-density discharges with gettered torus walls in DITE, 3:27625
TOKAMAK DEVICES/ENERGY LOSSES
Electron heat transport in a tokamak with destroyed magnetic surfaces, 3:27443
TOKAMAK DEVICES/FAST MAGNETOACOUSTIC WAVES
Eigenmode field structure of the fast magnetosonic wave in a Tokamak and loading impedance of coupling structures, 3:27428 (EUR-CEA-FC-886)
TOKAMAK DEVICES/HEAT TRANSFER
Electron heat transport in a tokamak with destroyed magnetic surfaces, 3:27443
TOKAMAK DEVICES/HIGH-FREQUENCY HEATING
Theoretical investigations of lower hybrid resonance heating in a tokamak, 3:27433 (JAERI-M-6964)
TOKAMAK DEVICES/ICR HEATING
Heating tokamaks via the ion-cyclotron and ion-ion hybrid resonances, 3:27584
TOKAMAK DEVICES/IMPURITIES
Calculations of impurity radiation and its effects on tokamak experiments, 3:27627
Model for heavy-impurity re-cycling at a limiter and limitation of power loss to a limiter in tokamaks, 3:27629
Temperature gradient effect on impurity-ion transport, 3:27504 (JAERI-M-6965)
Transport properties of a tokamak plasma with impurities in the collision-dominated regime, 3:27521
Trapping and removal of oxygen in tokamaks, 3:27628
TOKAMAK DEVICES/INSTABILITY GROWTH RATES
Magnetohydrodynamic equilibria and local stability of axisymmetric tokamak plasmas, 3:27437
TOKAMAK DEVICES/ION BEAM INJECTION
Cross-field injection, propagation, and energy deposition of intense ion beams with application to tokamak plasma heating, 3:27665
TOKAMAK DEVICES/ION DRIFT
Temperature gradient effect on impurity-ion transport, 3:27504 (JAERI-M-6965)
TOKAMAK DEVICES/LIMITERS
Model for heavy-impurity re-cycling at a limiter and limitation of power loss to a limiter in tokamaks, 3:27629
Tokamak boundary in contact with a limiter, 3:27630
TOKAMAK DEVICES/MAGNETOACOUSTIC WAVES
Magnetoacoustic-heating experiments in tokamak T-4 plasma, 3:27451
Note on the characters of the dispersion equation of fast magnetosonic wave near the second ion-cyclotron harmonic, 3:27561 (EUR-CEA-FC-895)
TOKAMAK DEVICES/MAGNETOHYDRODYNAMICS
Energy principles for non-ideal MHD, 3:27551
TOKAMAK DEVICES/NEUTRON FLUX
Neutron streaming problems in the 'FINTOR 1' design, 3:27609 (EUR-5602)
TOKAMAK DEVICES/ORBITS
Extensions of guiding center motion to higher order, 3:27508
TOKAMAK DEVICES/PLASMA CONFINEMENT
Summary of magnetic confinement (experiments), 3:27455
TOKAMAK DEVICES/PLASMA DIAGNOSTICS
Detection of the position and cross-section of a tokamak plasma with magnetic probes, 3:27468 (JAERI-M-6931)
TOKAMAK DEVICES/PLASMA DRIFT
Steady-state diffusion in a tokamak, 3:27525
TOKAMAK DEVICES/PLASMA HEATING
Rapid further heating of tokamak plasma by fast-rising magnetic pulse, 3:27453
TOKAMAK DEVICES/PLASMA INSTABILITY
Local, ideal and resistive stability in tokamaks with non-circular cross-section, 3:27557
Simulation of large magnetic islands: A possible mechanism for a major tokamak disruption, 3:27644
TOKAMAK DEVICES/RUNAWAY ELECTRONS
Formation of positive slope on electron runaway distribution in tokamaks, 3:27524
TOKAMAK DEVICES/SPECIFICATIONS
THOR tokamak engineering design and experimental programme, 3:27596 (EUR-5602)
TOKAMAK DEVICES/TRANSPORT THEORY
Drift-wave turbulence effects on magnetic structure and plasma transport in tokamaks, 3:27513
Steady-state diffusion in a tokamak, 3:27525
Transport properties of a tokamak plasma with impurities in the collision-dominated regime, 3:27521
TOKAMAK DEVICES/TRAPPED-PARTICLE INSTABILITY
Analytic solutions of the two-dimensional eigenvalue problem for the trapped-electron instability in tokamaks, 3:27445
Anomalous interaction of alpha particles with the dissipative trapped-ion mode, 3:27554
TOKAMAK TYPE REACTORS/ALFVEN WAVES
Alfven wave instability stabilization in a two-component tokamak, 3:27541 (IAE-2650)
TOKAMAK TYPE REACTORS/BANANA REGIME
Stationary temperature profile in a tokamak reactor operated in the neoclassical regime, 3:27518
TOKAMAK TYPE REACTORS/BEAM INJECTION HEATING
Study on plasma ignition of JAERI experimental fusion reactor, 3:27432 (JAERI-M-6876)
TOKAMAK TYPE REACTORS/DESIGN
Accessibility and replacement as prime constraints in the design of large experimental Tokamaks, 3:27593 (EUR-5602)
TOKAMAK TYPE REACTORS/EDDY CURRENTS
Eddy currents induced on the torus with non-uniform resistances, 3:27635 (JAERI-M-6953)
TOKAMAK TYPE REACTORS/ENERGY BALANCE
Plasma power balance models for self-sustained tokamak reactors, 3:27624
TOKAMAK TYPE REACTORS/FIRST WALL
Use and performance of graphite and metal ISSECs in tokamak fusion reactors, 3:27618 (UWFDM-202)
TOKAMAK TYPE REACTORS/FUEL CYCLE
Plasma studies of a catalyzed-D noncircular tokamak, 3:27655 (EUR-5602)
TOKAMAK TYPE REACTORS/HIGH-FREQUENCY HEATING
Plasma edge cooling during RF heating, 3:27436 (PPPL-1416)
TOKAMAK TYPE REACTORS/IMPURITIES
Plasma edge cooling during RF heating, 3:27436 (PPPL-1416)
TOKAMAK TYPE REACTORS/ION TEMPERATURE
Stationary temperature profile in a tokamak reactor operated in the neoclassical regime, 3:27518
TOKAMAK TYPE REACTORS/LIMITERS
Small radius start-up of tokamak plasmas with a moving limiter, 3:27435 (ORNL/TM-6111)
TOKAMAK TYPE REACTORS/MAGNET COILS
Trade study analysis for TNS tokamaks, 3:27642 (WFPS-TME-056)
TOKAMAK TYPE REACTORS/MAGNETIC FIELD CONFIGURATIONS
Toroidal field magnet system utilizing normal metal trimming coils, 3:27640 (UWFDM-225)
TOKAMAK TYPE REACTORS/MAINTENANCE
Tokamak reactor with servicing capability, 3:27699 (EUR-5602)
TOKAMAK TYPE REACTORS/NEUTRAL BEAM SOURCES
Neutral beam injector research and development work in the USA, 3:27663
TOKAMAK TYPE REACTORS/PHYSICAL RADIATION EFFECTS
Use and performance of graphite and metal ISSECs in tokamak fusion reactors, 3:27618 (UWFDM-202)
TOKAMAK TYPE REACTORS/PLASMA INSTABILITY
Alfven wave instability stabilization in a two-component tokamak, 3:27541 (IAE-2650)
Thermal thermonuclear instability in a tokamak reactor, 3:27550
TOKAMAK TYPE REACTORS/POWER SUPPLIES
Design study of electrical power supply system for tokamak fusion power reactor, 3:27649 (JAERI-M-6803)
TOKAMAK TYPE REACTORS/REACTOR MAINTENANCE
Tokamak reactor with servicing capability, 3:27699 (EUR-5602)
TOKAMAK TYPE REACTORS/RESEARCH PROGRAMS
Annual report of the Division of Thermonuclear Fusion Research, JAERI. Covering the period of April 1, 1975 to March 31, 1976, 3:27597 (JAERI-M-6926)
TOKAMAK TYPE REACTORS/SHIELDING
Use and performance of graphite and metal ISSECs in tokamak fusion reactors, 3:27618 (UWFDM-202)
TOKAMAK TYPE REACTORS/SUPERCONDUCTING COILS
Lateral support structure for constant tension D-shaped coils in tokamak fusion devices, 3:27643 (WFPS-TME-063)
TOKAMAK TYPE REACTORS/SUPERCONDUCTING MAGNETS
Design study of superconducting poloidal magnets for tokamak fusion power reactor, 3:27633 (JAERI-M-6802)
Design study of superconducting toroidal field magnet for tokamak fusion power reactor, 3:27634 (JAERI-M-6921)
Selection of the superconducting current-carrying element for the "T-10M" installation, 3:27645 (LA-tr-78-10)
Structural analysis methods and design solutions for OHMIC heating solenoids, 3:27641 (WFPS-TME-045)

Toroidal field magnet system utilizing normal metal trimming coils, 3:27640 (UWFDM-225)
TOKAMAK TYPE REACTORS/THERMONUCLEAR IGNITION
Small radius start-up of tokamak plasmas with a moving limiter, 3:27435 (ORNL/TM-6111)
TOKAMAK TYPE REACTORS/THERMONUCLEAR REACTORS
Plasma studies of a catalyzed-D noncircular tokamak, 3:27655 (EUR-5602)
TOKAMAK TYPE REACTORS/VACUUM SYSTEMS
Constructive and technological aspects of vacuum system design for demonstration thermonuclear reactor Tokamak, 3:27700 (EUR-5602)
Design study of pumping system for tokamak fusion power reactor, 3:27703 (JAERI-M-6922)
TONOPAH TEST RANGE/LAND RECLAMATION
Estimated inventory of plutonium and uranium radionuclides for vegetation in aged fallout areas, 3:26913 (NVO-171)
TONOPAH TEST RANGE/RADIATION MONITORING
Environmental plutonium on the Nevada Test Site and environs, 3:26909 (NVO-171)
TONOPAH TEST RANGE/RADIONUCLIDE MIGRATION
^{239}Pu and ^{241}Am contamination of small vertebrates in NAEG study areas of NTS and TTR, 3:26915 (NVO-171)
Estimated inventory of plutonium and uranium radionuclides for vegetation in aged fallout areas, 3:26913 (NVO-171)
TONOPAH TEST RANGE/TERRESTRIAL ECOSYSTEMS
^{239}Pu and ^{241}Am contamination of small vertebrates in NAEG study areas of NTS and TTR, 3:26915 (NVO-171)
Environmental plutonium on the Nevada Test Site and environs, 3:26909 (NVO-171)
TOROIDAL PINCH DEVICES/LINERS
Design aspects of a large toroidal stabilizing shell and vacuum liner assembly, 3:27696 (EUR-5602)
TOROIDAL PINCH DEVICES/MAGNETIC FIELD REVERSAL
Reversal of the toroidal magnetic field in pinches, 3:27631 (CLM-R-165)
TOROIDAL PINCH DEVICES/SHELLS
Design aspects of a large toroidal stabilizing shell and vacuum liner assembly, 3:27696 (EUR-5602)
TOROIDAL PINCH DEVICES/SPECIFICATIONS
Basic features of EXTRAP concept, 3:27598 (TRITA-PFU-77-01)
Plan and design of ETL TPE-2 experiment, 3:27595 (EUR-5602)
TOTAL ENERGY SYSTEMS/DEMONSTRATION PROGRAMS
Conceptual design Solar Total Energy Large Scale Experiment number 1. Final report (For US Army installation at Fort Hood,Texas), 3:26039 (TID-28013)
TOTAL ENERGY SYSTEMS/SOLAR ENERGY
Conceptual design Solar Total Energy Large Scale Experiment number 1. Final report (For US Army installation at Fort Hood,Texas), 3:26039 (TID-28013)
TOWER FOCUS POWER PLANTS/DESIGN
Educated ray trace approach to solar tower optics, 3:26037
Liquid metal cooled solar central receiver feasibility study and heliostat field analysis. Part I. Liquid sodium cooled central receiver system conceptual design. Final report, 3:26034 (ORO/5178-78-1)
TOWER FOCUS POWER PLANTS/HELIOSTATS
Central receiver solar thermal power system: collector subsystem. Final report, 3:26035 (SAN/1111-76-7)
Liquid metal cooled solar central receiver feasibility study and heliostat field analysis. Part I. Liquid sodium cooled central receiver system conceptual design. Final report, 3:26034 (ORO/5178-78-1)
TOWER FOCUS POWER PLANTS/PLANNING
Development of solar tower program in the United States, 3:26036
TOXICITY/FORECASTING
Priori predictive methods of assessing health effects of chemicals in the environment, 3:26878 (LBL-6372)
TRANSALASKA PIPELINE
See ALASKA OIL PIPELINE
TRANSDUCERS/DESIGN
Instrumentation for the measurement of vibration in severe environments, such as nuclear reactors, 3:26374
Ultrasonic wave generator (Patent), 3:26377
TRANSFER (HEAT)
See HEAT TRANSFER
TRANSISTORS/PHYSICAL RADIATION EFFECTS
Ionizing radiation effects on silicon-on-sapphire devices and silicon dioxide films. Final report May 76-Apr 77, 3:26836 (AD-A-046169)
TRANSITIONS (FORBIDDEN)
See FORBIDDEN TRANSITIONS
TRANSLATORS
ACT: an 8080 MACRO processor (Macro text interpreter for Intel 8080), 3:27710 (UCID-17722)
TRANSPORTATION SECTOR/ENERGY ANALYSIS
Energy and Resource Planning Group FY 1977 annual report (Use of LLL Energy Model (LLLEM)), 3:26495 (UCRL-50029-77)
TRANSPORTATION SYSTEMS/ENERGY LOSSES
Strategy for energy conservation through tribology, 3:26706 (TID-28175)
TRANSURANIUM ELEMENTS
See also PLUTONIUM
TRANSURANIUM ELEMENTS/ENVIRONMENTAL TRANSPORT
Environmental plutonium on the Nevada Test Site and environs, 3:26909 (NVO-171)
TRANSVERSE MOMENTUM
Large transverse momentum phenomena, 3:27205 (SLAC-PUB-2009)
Recent developments in the theory of large transverse momentum processes, 3:27119 (SLAC-PUB-1806)
TRAPPED-PARTICLE INSTABILITY/DISTRIBUTION FUNCTIONS
Anomalous interaction of alpha particles with the dissipative trapped-ion mode, 3:27554
TRAPPED-PARTICLE INSTABILITY/FLUCTUATIONS
Observation of the dissipative trapped electron instability in toroidal geometry, 3:27543
TREES
See also PINES
TREES/CLONING
Genetic selection, physiological basis of vigor, tissue culture (Sycamore-Plantanus occidentalis), 3:26024 (SRO-0888-2)
TREES/PLANT GROWTH
Genetic selection, physiological basis of vigor, tissue culture (Sycamore-Plantanus occidentalis), 3:26024 (SRO-0888-2)
TRIPLET PARTICLES
See QUARKS
TRITIUM TARGET/PION MINUS REACTIONS
Elastic scattering of π^{+-} on ^{3}He and ^{3}He (Differential cross sections, 233 to 300 MeV/C experiment in progress), 3:27320 (ORO-4043-37)
TRITIUM TARGET/PION PLUS REACTIONS
Elastic scattering of π^{+-} on ^{3}He and ^{3}He (Differential cross sections, 233 to 300 MeV/C experiment in progress), 3:27320 (ORO-4043-37)
TRITON REACTIONS/FISSION
Fission of ^{240}U in the reaction ^{238}U(t,pf), 3:27385
TRITON REACTIONS/STRIPPING
Analyzing-power measurements for the ^{3}He(t,d)^{4}He reaction, 3:27324
TROPOSPHERE/ACOUSTIC MONITORING
Acoustic detection of momentum transfer during the abrupt transition from a laminar to a turbulent atmospheric boundary layer[1], 3:26867
TROPOSPHERE/BOUNDARY LAYERS
Acoustic detection of momentum transfer during the abrupt transition from a laminar to a turbulent atmospheric boundary layer[1], 3:26867
TRYPTOPHAN/BIOCHEMICAL REACTION KINETICS
Photorepair of uv damage to DNA: purification and properties of DNA photolyase (the DNA-photoreactivating enzyme). Progress and final reports, August 1, 1976-July 31, 1977, 3:26948 (ORO-3630-26)
TTF-TCNQ
(Tetrathiafulvalene tetracyanoquinodimethane.)
TTF-TCNQ/NEUTRON DIFFRACTION
Re-examination of the inelastic neutron scattering in tetrathiafulvalene-tetracyanoquinodimethane (TTF-TCNQ), 3:26650
TTF-TCNQ/PHONONS
Re-examination of the inelastic neutron scattering in tetrathiafulvalene-tetracyanoquinodimethane (TTF-TCNQ), 3:26650
TUBES (CONDUITS)
See PIPES
TUMOR CELLS/DNA
Impulse cytophotometric investigations on melanoblastoma, 3:26965 (LA-tr-78-2)
TUMOR CELLS/PHOTOMETRY
Impulse cytophotometric investigations on melanoblastoma, 3:26965 (LA-tr-78-2)
TUMOR CELLS/SAMPLING
Automated cancer-cell sorting and analysis. Progress report, June 1-November 30, 1977, 3:26961 (LA-7076-PR)
TUMORS
See NEOPLASMS
TUNGSTATES/CATALYTIC EFFECTS
Studies on catalysts for low-temperature steam-reforming of hydrocarbons. IV. Kinetics of reaction on the Rh-$MgWO_4$ catalyst, 3:25784

TUNGSTEN/CHEMICAL VAPOR DEPOSITION
Optical properties of thin film refractory metals (Spectrally selective surfaces for solar absorbers), 3:26069
TUNGSTEN/EMISSIVITY
Integral hemispherical degree of blackness of alloys of high-melting metals at high temperatures, 3:26622
Optical properties of metals at high temperatures, 3:26619
TUNGSTEN/ION EXCHANGE
Cation exchange of 53 elements in nitric acid, 3:26665 (LA-7083)
TUNGSTEN/OPTICAL PROPERTIES
Optical properties of thin film refractory metals (Spectrally selective surfaces for solar absorbers), 3:26069
TUNGSTEN/THERMAL EXPANSION
Features of the expansion of condensed substances acted on by high-power shock waves, 3:26613
TUNGSTEN 184 TARGET/OXYGEN 18 REACTIONS
Long-range absorption in the heavy-ion optical potential, 3:27369
TUNGSTEN ALLOYS/EMISSIVITY
Integral hemispherical degree of blackness of alloys of high-melting metals at high temperatures, 3:26622
TUNGSTEN ALLOYS/THERMAL EXPANSION
Experimental study of the thermal expansion of various construction materials. Tantalum and tantalum-tungsten TV-10 alloy, 3:26617
TUNGSTEN FLUORIDES/MAGNETIC RESONANCE
Optical and zero field magnetic resonance spectroscopy of inorganic molecular solids. Final report, 1 June 1975-31 May 1977, 3:26645 (AD-A-043340)
TUNGSTEN FLUORIDES/OPTICAL PROPERTIES
Optical and zero field magnetic resonance spectroscopy of inorganic molecular solids. Final report, 1 June 1975-31 May 1977, 3:26645 (AD-A-043340)
TURBOGENERATORS/ENERGY LOSSES
Strategy for energy conservation through tribology, 3:26706 (TID-28175)
TURBOJET ENGINES/INTAKE STRUCTURES
Accelerated iterative calculation of transonic nacelle flowfields, 3:27091
TURBULENT HEATING/REVIEWS
Roles of turbulence on plasma heating, 3:27431 (IPPJ-255)
TWO-PHASE FLOW/COMPUTER CODES
Calculation of two-phase flow and fracturing in a porous medium (abstract), 3:26085
TWO-PHASE FLOW/CRITICAL FLOW
Calculation of two-phase critical flow using the model of disperse: annular flow, 3:26771
Critical conditions with unsteady-state outflow of a two-phase medium with a pipeline break, 3:26773
TWO-PHASE FLOW/DISTURBANCES
Propagation speeds for perturbations in a flow of a two-phase mixture, 3:26774
TWO-PHASE FLOW/VAPOR CONDENSATION
Analysis of nonsteady flows with phase conversions, 3:26772
TWO-PHASE FLOW/VELOCITY
Propagation speeds for perturbations in a flow of a two-phase mixture, 3:26774
TWO-STREAM INSTABILITY/PLASMA SIMULATION
Quasi-neutral particle simulation model with application to ion wave propagation, 3:27570
TYPE-II SUPERCONDUCTORS/ENERGY-LEVEL DENSITY
Estimate of density-of-states changes with disorder in A-15 superconductors, 3:26602
TYPE-III SUPERCONDUCTORS
See TYPE-II SUPERCONDUCTORS

U

U-1 GROUPS/GAUGE INVARIANCE
U(1) gauge theories, fiber bundles, and stereographic projections in two dimensions, 3:27277
UCLLL
See LAWRENCE LIVERMORE LABORATORY
U-GAS PROCESS/DEMONSTRATION PLANTS
Fossil energy demonstration plants, 3:25642 (TID-28182)
UINTA BASIN/NATURAL GAS DEPOSITS
Possible future petroleum of Uinta and Piceance basins and vicinity: northeast Utah and northwest Colorado, 3:25726
UINTA BASIN/PETROLEUM DEPOSITS
Possible future petroleum of Uinta and Piceance basins and vicinity: northeast Utah and northwest Colorado, 3:25726
UJM
See JET MODEL
ULTRACOLD NEUTRONS/STORAGE
Hydrogen surface contamination and the storage of ultracold neutrons, 3:27315
ULTRAHIGH-SPEED PHOTOGRAPHY
Marco image converter camera. Period covered: July-September 1977, 3:26838 (MHSMP-77-50)
UNCORRELATED-JET MODEL
See JET MODEL
UNDERGROUND EXPLOSIONS
See also MILROW EVENT
NUCLEAR EXPLOSIONS
Permeability from single and multiple detonations in boreholes, 3:25702
UNDERGROUND EXPLOSIONS/ENVIRONMENTAL EFFECTS
History, 1741-1967, 3:26922 (TID-26712)
Marine fish communities, 3:26927 (TID-26712)
Radionuclides in air, water, and biota (^{40}K, ^{7}Be, ^{137}Cs), 3:26934 (TID-26712)
UNDERGROUND HEAT DISTRIBUTION SYSTEMS
See HEAT DISTRIBUTION SYSTEMS
UNDERGROUND MINING
See also LONGWALL MINING
OIL SHALE MINING
ROOM AND PILLAR MINING
UNDERGROUND MINING/DIESEL ENGINES
Experiments with novel fuels for diesel engines, 3:26591 (BERC/TPR-77/8)
UNDERGROUND MINING/ROOFS
Dry-process-sprayed coal mine sealants, an updated progress report, 3:25690 (BM-RI-8266)
UNDERGROUND MINING/SAFETY
Dry-process-sprayed coal mine sealants, an updated progress report, 3:25690 (BM-RI-8266)
UNDERGROUND MINING/STIRLING ENGINES
Stirling engine: an option for underground mines, 3:26577 (BERC/RI-78/3)
UNDERWATER VEHICLES
See SUBMARINES
UNIFIED GAUGE MODELS/COLOR MODEL
Chiral properties of the fermionic determinant in quantum chromodynamics, 3:27245
UNIFIED GAUGE MODELS/GAUGE INVARIANCE
Superunified theories based on the geometry of local (super-) gauge invariance, 3:27273
UNIFIED GAUGE MODELS/GLUON MODEL
Topological tunneling and Goldstone gluons, 3:27254
UNIFIED GAUGE MODELS/GRAVITATIONAL FIELDS
Superunified theories based on the geometry of local (super-) gauge invariance, 3:27273
UNIFIED GAUGE MODELS/INTERMEDIATE MASS NUCLEI
Unified model studies of N = 84 and N = 80 nuclei, 3:27367 (IS-T-793)
UNIFIED GAUGE MODELS/RENORMALIZATION
Supercurrent anomaly in a supersymmetric gauge theory, 3:27243
UNIFIED GAUGE MODELS/SU GROUPS
Gauge groups without triangular anomaly, 3:27262
UNIFIED GAUGE MODELS/SYMMETRY BREAKING
Broken gauge and scale invariance, 3:27253
Possible supersymmetry breaking by pseudoparticles, 3:27244
Supercurrent anomaly in a supersymmetric gauge theory, 3:27243
Topological tunneling and Goldstone gluons, 3:27254
UNIFIED GAUGE MODELS/VACUUM STATES
Topological tunneling and Goldstone gluons, 3:27254
UNITED KINGDOM/COAL INDUSTRY
Medium-term aspects of a coal revival: two case studies, 3:25721 (IIASA-CP-77-5)
UNITED KINGDOM/ENERGY DEMAND
Medium-term aspects of a coal revival: two case studies, 3:25721 (IIASA-CP-77-5)
UNITED KINGDOM/ENERGY POLICY
Towards a more conservative energy policy (Booklet), 3:26517
UK strategy and programmes for advanced LMFBR fuels, 3:26294
UNITED KINGDOM/ENERGY SUPPLIES
Medium-term aspects of a coal revival: two case studies, 3:25721 (IIASA-CP-77-5)
UNITED KINGDOM/LMFBR TYPE REACTORS
UK irradiation experience relevant to advanced oxide fuel concepts for LMFBR's, 3:26300
UK strategy and programmes for advanced LMFBR fuels, 3:26294
UNITED KINGDOM/NUCLEAR POWER
Nuclear power. Its development in the United Kingdom, 3:26206
Sunningdale seminar on nuclear policy: a summary of the discussions, 3:26333
UNITED STATES OF AMERICA
See USA
UNIVERSITY OF WISCONSIN TOKAMAK
See UWMAK DEVICES
UNLOADING (REACTOR)
See REACTOR FUELING

UPSILON RESONANCES/DECAY
Newly found resonance Y (9.5) and the charge of the heavy quark, 3:27148
UPSILON RESONANCES/ENERGY SPECTRA
Interpretation of the Y (9.5) as evidence for another quark, 3:27185
UPSILON RESONANCES/PARTICLE PRODUCTION
Newly found resonance Y (9.5) and the charge of the heavy quark, 3:27148
URAGAN STELLARATOR/SPECIFICATIONS
Uragan-2 experimental thermonuclear device of stellarator type, 3:27606
URANINITES/SOLUBILITY
Uranium solubilities in the Oklo reactor zones, 3:27016 (LA-UR-77-2818)
URANIUM
See also ENRICHED URANIUM
URANIUM-ALPHA
URANIUM/ABUNDANCE
Rare earth and other trace elements in historic Azorean lavas, 3:27009
URANIUM/BODY BURDEN
Hazard analysis of uranium inhalation at the Lawrence Livermore Laboratory, 3:26998 (UCID-17673)
URANIUM/CHARGES
Annual summary of cost and quality of electric utility plant fuels, 1976, 3:25722 (TID-28133)
URANIUM/CONSUMPTION RATES
Annual summary of cost and quality of electric utility plant fuels, 1976, 3:25722 (TID-28133)
URANIUM/COSTER-KRONIG TRANSITIONS
L shell fluorescence yields and Coster-Kronig transition probabilities using radioactive sources. Final report, 3:27056 (AD-A-042228)
URANIUM/DIFFUSION
Uranium solubilities in the Oklo reactor zones, 3:27016 (LA-UR-77-2818)
URANIUM/ENERGY-LEVEL TRANSITIONS
Experimental determination of the angular distribution of transition radiation following photoeffect, 3:27060
URANIUM/GEOCHEMISTRY
Investigation of uranium-1 and uranium-containing minerals by luminescence spectra, 3:25905
URANIUM/INHALATION
Hazard analysis of uranium inhalation at the Lawrence Livermore Laboratory, 3:26998 (UCID-17673)
URANIUM/ULTRAVIOLET SPECTRA
High-lying levels in uranium atomic vapor near the ionization limit, 3:27061
URANIUM/X-RAY SPECTRA
Experimental determination of the angular distribution of transition radiation following photoeffect, 3:27060
L shell fluorescence yields and Coster-Kronig transition probabilities using radioactive sources. Final report, 3:27056 (AD-A-042228)
URANIUM 233/ENVIRONMENTAL TRANSPORT
Ecology of Hanford 200 Area and 1976 radionuclide inventory, 3:25944 (PNL-2253)
URANIUM 233 TARGET/NEUTRON REACTIONS
Thermal-neutron fission of ^{233}U and ^{235}U accompanied by emission of α particles at small angles to the fission axis, 3:27384
URANIUM 234/PURIFICATION
Recovery and purification of uranium-234 from aged plutonium-238, 3:26666 (MLM-2490)
URANIUM 234/RECOVERY
Recovery and purification of uranium-234 from aged plutonium-238, 3:26666 (MLM-2490)
URANIUM 235/BIOLOGICAL RADIATION EFFECTS
Estimated inventory of plutonium and uranium radionuclides for vegetation in aged fallout areas, 3:26913 (NVO-171)
URANIUM 235/ENVIRONMENTAL TRANSPORT
Estimated inventory of plutonium and uranium radionuclides for vegetation in aged fallout areas, 3:26913 (NVO-171)
URANIUM 235/ISOTOPE SEPARATION
Allocation of uranium enrichment services to fuel foreign and domestic nuclear reactors, 3:25915 (ID-75-45)
Update on uranium enrichment in South Africa. An overview of the uranium scene in the Republic, 3:25916
URANIUM 235/LASER ISOTOPE SEPARATION
Cost analyses of uranium enrichment by laser isotope separation process, 3:25920
Optimum operating conditions for a laser uranium enrichment plant, 3:25918
URANIUM 235/PARTICLE RESUSPENSION
Estimated inventory of plutonium and uranium radionuclides for vegetation in aged fallout areas, 3:26913 (NVO-171)
URANIUM 235 TARGET/NEUTRON REACTIONS
Thermal-neutron fission of ^{233}U and ^{235}U accompanied by emission of α particles at small angles to the fission axis, 3:27384
URANIUM 235 TARGET/**PHOTONUCLEAR REACTIONS**
Pre-equilibrium particle decay in the photonuclear reactions, 3:27327
URANIUM 238/ISOTOPE SEPARATION
Update on uranium enrichment in South Africa. An overview of the uranium scene in the Republic, 3:25916
URANIUM 238 TARGET/CARBON 12 REACTIONS
Measurement of the effective widths of excited states of heavy nuclei (Z=98, 100, 102) by means of the blocking effect, 3:27382
URANIUM 238 TARGET/**NEON 22 REACTIONS**
Measurement of the effective widths of excited states of heavy nuclei (Z=98, 100, 102) by means of the blocking effect, 3:27382
URANIUM 238 TARGET/**OXYGEN 18 REACTIONS**
Measurement of the effective widths of excited states of heavy nuclei (Z=98, 100, 102) by means of the blocking effect, 3:27382
URANIUM 238 TARGET/**PROTON REACTIONS**
Energy dependence of the pseudorapidity distributions in proton-nucleus collisions between 50 and 200 GeV/c, 3:27124
URANIUM 238 TARGET/**TRITON REACTIONS**
Fission of ^{240}U in the reaction ^{238}U(t,pf), 3:27385
URANIUM BASE ALLOYS/HEAT TREATMENTS
Development of an aging integrator for uranium-0.75 weight percent titanium alloy part aging control, 3:26595 (Y-2101)
URANIUM CARBIDES/CHEMICAL RADIATION EFFECTS
Chemical state of irradiated carbide fuel pins (LMFBR), 3:26641
URANIUM CARBIDES/**CREEP**
Creep behavior of mixed-carbide advanced nuclear fuel (LMFBR), 3:26635
URANIUM CARBIDES/**MECHANICAL PROPERTIES**
Fuel properties of advanced fuels (U,Pu)CN important for out-of-pile and in-pile kinetics (LMFBR), 3:26634
URANIUM CARBIDES/**PHYSICAL RADIATION EFFECTS**
Analytical comparison of the irradiation behavior of fast reactor carbide and oxide fuel pins (LMFBR), 3:26319
Chemical state of irradiated carbide fuel pins (LMFBR), 3:26641
CNEN program on advanced LMFBR fuels, 3:26299
Correlation between properties and irradiation behavior for carbide, carbonitride and nitride fuels (LMFBR), 3:26316
French irradiation test experience for carbide fuels (LMFBR), 3:26309
German carbide irradiation test experience for fast reactors (LMFBR), 3:26308
Irradiation behavior of sphere-pac carbide fuel (LMFBR), 3:26310
Irradiation experiments of uranium carbide, carbonitride, and nitride fuels in JAERI (LMFBR), 3:26311
Irradiation performance analysis of UK fast reactor fuel (LMFBR), 3:26317
Progress in modeling carbide and nitride fuel performance in advanced LMFBRs, 3:26318
UK irradiation experience relevant to advanced carbide fuel concepts for LMFBR's, 3:26307
US advanced LMFBR fuels development program, 3:26293
URANIUM CARBIDES/**THERMODYNAMIC PROPERTIES**
Some observations on oxygen and carbon potentials in U-Pu-O and U-Pu-C systems (LMFBR), 3:26599
Thermophysical properties of liquid uranium carbide (LMFBR), 3:26633
URANIUM COMPOUNDS/MAGNETIC RESONANCE
Optical and zero field magnetic resonance spectroscopy of inorganic molecular solids. Final report, 1 June 1975-31 May 1977, 3:26645 (AD-A-043340)
URANIUM COMPOUNDS/**OPTICAL PROPERTIES**
Optical and zero field magnetic resonance spectroscopy of inorganic molecular solids. Final report, 1 June 1975-31 May 1977, 3:26645 (AD-A-043340)
URANIUM DEPOSITS/GAMMA LOGGING
Manual on gamma logging in search and exploration of uranium deposts, 3:25913
URANIUM DEPOSITS/GEOCHEMICAL SURVEYS
Geology of uranium deposits in the Madison Limestone Little Mountain area, Big Horn County, Wyoming, 3:25910
Uranium geochemical prospecting in Salzburg Province, Austria, 3:25922
URANIUM DEPOSITS/GEOPHYSICAL SURVEYS
Geology of uranium deposits in the Madison Limestone Little Mountain area, Big Horn County, Wyoming, 3:25910
Geophysical techniques used in uranium exploration, 3:25909
URANIUM DEPOSITS/LEACHING
Chemical factors in in-situ uranium leach mining, 3:25914
URANIUM DEPOSITS/NEUTRON-NEUTRON LOGGING
Pulsed neutron generator for logging, 3:25908
URANIUM DEPOSITS/ORIGIN
Uranium deposits of the Grants mineral belt: geochemical constraints on origin, 3:25911

URANIUM DEPOSITS/PROSPECTING
Data management and handling for the Hydrogeochemical and Stream Sediment Reconnaissance program at the Los Alamos Scientific Laboratory, 3:25907 (LA-7128-MS)
URANIUM DEPOSITS/SOLUTION MINING
Chemical factors in in-situ uranium leach mining, 3:25914
URANIUM DIOXIDE/CHEMICAL RADIATION EFFECTS
US-UK technical exchange breeder reactor fuels: fuel pin chemistry, 3:26282 (HEDL-6297)
URANIUM DIOXIDE/CRYSTAL-PHASE TRANSFORMATIONS
Search criterion for lattice internal rearrangement modes: Correlation between lattice structural and magnetic structural transitions, 3:26630
URANIUM DIOXIDE/MAGNETOSTRICTION
Search criterion for lattice internal rearrangement modes: Correlation between lattice structural and magnetic structural transitions, 3:26630
URANIUM DIOXIDE/MECHANICAL PROPERTIES
Response of unirradiated and irradiated PWR fuel rods tested under power-cooling-mismatch conditions, 3:26443 (TREE-NUREG-1196)
URANIUM DIOXIDE/PHYSICAL RADIATION EFFECTS
Analytical comparison of the irradiation behavior of fast reactor carbide and oxide fuel pins (LMFBR), 3:26319
CNEN program on advanced LMFBR fuels, 3:26299
Experience and future plan of fast reactor oxide fuels irradiation in Japan, 3:26301
Irradiation performance analysis of UK fast reactor fuel (LMFBR), 3:26317
LIFE code system for analysis of oxide fuel pin thermal/structural behavior (LMFBR), 3:26320
Mechanical behavior of a fuel pin for fast reactors: effect of the fuel form and of the approach-to-power on the change of the fuel stack length under irradiation, 3:26302
Properties and irradiation behavior of advanced oxide particle fuel (LMFBR, BWR, PWR), 3:26305
UK irradiation experience relevant to advanced oxide fuel concepts for LMFBR's, 3:26300
US advanced LMFBR fuels development program, 3:26293
US experience in irradiation testing of advanced oxide fuels (LMFBR), 3:26303
URANIUM DIOXIDE/THERMODYNAMIC PROPERTIES
Some observations on oxygen and carbon potentials in U-Pu-O and U-Pu-C systems (LMFBR), 3:26599
URANIUM HEXAFLUORIDE/MAGNETIC RESONANCE
Optical and zero field magnetic resonance spectroscopy of inorganic molecular solids. Final report, 1 June 1975-31 May 1977, 3:26645 (AD-A-043340)
URANIUM HEXAFLUORIDE/OPTICAL PROPERTIES
Optical and zero field magnetic resonance spectroscopy of inorganic molecular solids. Final report, 1 June 1975-31 May 1977, 3:26645 (AD-A-043340)
URANIUM HYDRIDES/CHEMICAL REACTIONS
Tracer experiments on the reaction of UH_3 in water, 3:26699 (AD-239162)
URANIUM ISOTOPES/ISOTOPE SEPARATION
French research in the field of uranium enrichment, 3:25917
URANIUM ISOTOPES/LASER ISOTOPE SEPARATION
Optimum operating conditions for a laser uranium enrichment plant, 3:25919
URANIUM ISOTOPES/RADIATION MONITORING
Revegetation of a waste disposal site in the 200 areas of the Hanford Reservation, 3:26908 (PNL-2454)
URANIUM MINERALS
See also URANINITES
URANIUM MINERALS/LUMINESCENCE
Investigation of uranium-1 and uranium-containing minerals by luminescence spectra, 3:25905
URANIUM NITRIDES/MECHANICAL PROPERTIES
Fuel properties of advanced fuels (U,Pu)CN important for out-of-pile and in-pile kinetics (LMFBR), 3:26634
URANIUM NITRIDES/PHYSICAL RADIATION EFFECTS
Correlation between properties and irradiation behavior for carbide, carbonitride and nitride fuels (LMFBR), 3:26316
Irradiation experiments of uranium carbide, carbonitride, and nitride fuels in JAERI (LMFBR), 3:26311
Mixed-nitride fuel performance in EBR-II (LMFBR), 3:26306
Progress in modeling carbide and nitride fuel performance in advanced LMFBRs, 3:26318
US advanced LMFBR fuels development program, 3:26293
URANIUM ORES/ACTIVATION ANALYSIS
Uranium abundance in some Precambrian and Phanerozoic rocks from New Mexico, 3:25912
URANIUM ORES/AGE ESTIMATION
Possible uranium-ruthenium method for measurement of ore age, 3:25903 (LA-UR-77-2863)
URANIUM ORES/GEOLOGY
Potassium-sodium metasomatites of a hydrothermal, uranium-molybdenum ore deposit, 3:25906
URANIUM ORES/ISOTOPIC EXCHANGE
Uranium solubilities in the Oklo reactor zones, 3:27016 (LA-UR-77-2818)
URANIUM ORES/PETROGENESIS
Hydrogen - a reducing agent in some uranium deposits, 3:25904
URANIUM RESERVES/FORECASTING
Can world meet 300,000 tonnes supply challenge, 3:25925
URANIUM RESERVES/GLOBAL ASPECTS
Can world meet 300,000 tonnes supply challenge, 3:25925
URANIUM-ALPHA/MAGNETIZATION
Induced magnetization density in α-uranium, 3:26605
URBAN AREAS/DISTRICT HEATING
District heating as a task for government and economy. Existing networks to be extended systematically: special responsibilities for communities, 3:26508
US DOE/RESEARCH PROGRAMS
Electric Hybrid Vehicle Program contractors' coordination meeting: summary, oversight, and review, 3:26581 (UCRL-13805)
USA
See also ALASKA
APPALACHIA
ARIZONA
CALIFORNIA
COLORADO
HAWAII
IDAHO
ILLINOIS
MONTANA
NEBRASKA
NEVADA
NEW MEXICO
NEW YORK
OREGON
TEXAS
UTAH
WASHINGTON
WYOMING
USA/AGRICULTURE
Energy use in agriculture: now and for the future, 3:26530
USA/BWR TYPE REACTORS
Licensed operating reactors. Operating units status report, data as of 12-31-77, 3:26209 (NUREG-0020(Vol.2)(No.1))
Nuclear power plants. Construction status report, data as of December 31, 1977, 3:26210 (NUREG-0030-78/01)
USA/ELECTRIC UTILITIES
Statistics of publicly owned electric utilities in the United States, 3:26523 (NP-22952)
USA/ENERGY CONSUMPTION
International energy trends: 3rd quarter 1977 and recent trends, 3:26528 (NP-23033)
USA/GEOCHEMICAL SURVEYS
Data management and handling for the Hydrogeochemical and Stream Sediment Reconnaissance program at the Los Alamos Scientific Laboratory, 3:25907 (LA-7128-MS)
USA/LMFBR TYPE REACTORS
US experience in irradiation testing of advanced oxide fuels (LMFBR), 3:26303
USA/NATURAL GAS DEPOSITS
National gas survey. Volume 1. The Commission report (Book), 3:25824
USA/NUCLEAR POWER PLANTS
Licensed operating reactors. Operating units status report, data as of 12-31-77, 3:26209 (NUREG-0020(Vol.2)(No.1))
Nuclear power plants. Construction status report, data as of December 31, 1977, 3:26210 (NUREG-0030-78/01)
USA/POLLUTION LAWS
State air pollution implementation plan. Progress report, July 1-December 31, 1974, 3:26877 (EPA-450/2-75-003)
USA/PWR TYPE REACTORS
Licensed operating reactors. Operating units status report, data as of 12-31-77, 3:26209 (NUREG-0020(Vol.2)(No.1))
Nuclear power plants. Construction status report, data as of December 31, 1977, 3:26210 (NUREG-0030-78/01)
USA/REVIEWS
Alternatives to LNG in the United States, 3:26513
USA/WATER QUALITY
Nationwide assessment of water quantity impacts of the National Energy Plan. Volume I. Summary and conclusions, 3:26932 (ORNL/TM-6098)
USA/WATER REQUIREMENTS
Nationwide assessment of water quantity impacts of the National Energy Plan. Volume I. Summary and conclusions, 3:26932 (ORNL/TM-6098)

USSR/COAL DEPOSITS
Underground investigation of the hydraulic fracture zone along the iota$_7$ seam at the Lisichansk Podzemgaz Station, 3:25705 (UCRL-Trans-11318)
USSR/ENERGY SOURCES
Nuclear fuel in the fuel and energy complex, 3:26507
USSR/GEOCHEMICAL SURVEYS
Use of neutron-gamma logging data normalized from readings in a reference borehole to estimate the volume water content of carbonate rocks, 3:27019 (UCRL-Trans-11309)
USSR/HEAT FLOW
Heat field of petroliferous regions of Ciscaucasia, 3:26107
USSR/NATURAL GAS DEPOSITS
Experience of application of multidimensional regression analysis in connection with integrated interpretation of local gravitational anomalies of structurally complex regions of Azerbaijan, 3:25742
USSR/NUCLEAR POWER
Nuclear fuel in the fuel and energy complex, 3:26507
USSR/PETROLEUM DEPOSITS
Character of distribution of naphthene acids in petroleums of lower Kura depression deposits, 3:25817
Experience of application of multidimensional regression analysis in connection with integrated interpretation of local gravitational anomalies of structurally complex regions of Azerbaijan, 3:25742
USSR/VOLCANISM
Possible association between intensity of modern volcanism and horizontal movements of the crust in eastern Kamchatka, 3:27008
UTAH/ENERGY SOURCE DEVELOPMENT
Western States energy resource development update 1976, 3:26503
UTAH/NATURAL GAS DEPOSITS
Geology and petroleum of the Mancos B formation, Douglas Creek arch area, Colorado and Utah, 3:25738
Petroleum potential of southwestern Wyoming and adjacent areas, 3:25737
UTAH/OIL SHALE DEPOSITS
Oil shale and the environment, 3:25902 (EPA-600/9-77-033)
UTAH/PETROLEUM DEPOSITS
Geology and petroleum of the Mancos B formation, Douglas Creek arch area, Colorado and Utah, 3:25738
Petroleum potential of southwestern Wyoming and adjacent areas, 3:25737
UWMAK DEVICES
(University of Wisconsin Tokamak.)
UWMAK DEVICES/SPECIFICATIONS
High-performance non-circular tokamak power reactor design study - UWMAK-III, 3:27601

V

VACUUM STATES/DECAY
Decay of metastable vacuums in the massive Schwinger model, 3:27271
VACUUM SYSTEMS
Effect of vacuum conditions on plasma production and confinement, 3:27698 (EUR-5602)
VACUUM SYSTEMS/DEGASSING
Glow discharge processing vs bakeout for aluminum storage ring vacuum chambers, 3:26815 (SLAC-PUB-2053)
VACUUM SYSTEMS/DESIGN
Constructive and technological aspects of vacuum system design for demonstration thermonuclear reactor Tokamak, 3:27700 (EUR-5602)
VACUUM SYSTEMS/PLANNING
Design study of pumping system for tokamak fusion power reactor, 3:27703 (JAERI-M-6922)
VALVES/BIBLIOGRAPHIES
Fittings in energy engineering, 3:26368
VALVES/MAINTENANCE
Countermeasures to prevent leakage from valve stem area, 3:26370
VALVES/MATERIALS TESTING
Evaluation of materials for use in letdown valves and coal feed pumps for coal liquefaction service. Final report, 3:25647 (EPRI-AF-579)
VALVES/PERFORMANCE TESTING
SPTF Flow Loop 18 inch butterfly valve cavitation test report, SPTF-LPP (LMFBR), 3:26284 (TID-28094)
VALVES/SEALS
Countermeasures to prevent leakage from valve stem area, 3:26370
VAN DE GRAAFF ACCELERATORS/OPERATION
Physics Division annual review, 1 April 1976-31 March 1977 (ANL), 3:27312 (ANL-77-60)
VANADIUM/EMISSION SPECTROSCOPY
Determination of trace elements in soft, hard, and saline waters by the inductively coupled plasma, multi-element atomic emission spectroscopic (ICP-MAES) technique, 3:26664
VANADIUM/ION EXCHANGE
Cation exchange of 53 elements in nitric acid, 3:26665 (LA-7083)
VANADIUM/PHOTOEMISSION
X-ray photoemission spectra of the valence bands of the 3d transition metals, Sc to Fe, 3:26608
VANADIUM 51 TARGET/OXYGEN 16 REACTIONS
High-spin states in ^{64}Zn, 3:27357
VANADIUM ALLOYS/CREEP
Titanium and titanium alloy creep (a bibliography with abstracts). Report for 1964-September 1977, 3:26598 (NTIS/PS-77/0803)
VANADIUM COMPOUNDS/CHEMICAL PREPARATION
Synthesis and characterization of $[(eta^5\text{-}C_5H_5)V(CO)_3H]^-$, a new anionic vanadium carbonyl hydride, and a study of its reduction reaction with organic halides. Observation of a free-radical chain process having an extremely rapid metal-to-carbon hydrogen transfer step, 3:26676
VANADIUM COMPOUNDS/CHEMICAL REACTIONS
Synthesis and characterization of $[(eta^5\text{-}C_5H_5)V(CO)_3H]^-$, a new anionic vanadium carbonyl hydride, and a study of its reduction reaction with organic halides. Observation of a free-radical chain process having an extremely rapid metal-to-carbon hydrogen transfer step, 3:26676
VANADIUM HYDRIDES/CHEMICAL PREPARATION
Synthesis and characterization of $[(eta^5\text{-}C_5H_5)V(CO)_3H]^-$, a new anionic vanadium carbonyl hydride, and a study of its reduction reaction with organic halides. Observation of a free-radical chain process having an extremely rapid metal-to-carbon hydrogen transfer step, 3:26676
VANADIUM HYDRIDES/CHEMICAL REACTIONS
Synthesis and characterization of $[(eta^5\text{-}C_5H_5)V(CO)_3H]^-$, a new anionic vanadium carbonyl hydride, and a study of its reduction reaction with organic halides. Observation of a free-radical chain process having an extremely rapid metal-to-carbon hydrogen transfer step, 3:26676
VARIABLE STARS/INSTABILITY
Instability strip of the anomalous Cepheids in the Draco dwarf spheroidal galaxy, 3:27023
VECTOR MESONS
(Mesons with spin-one.)
See also OMEGA-784 RESONANCES
PHI-1019 RESONANCES
PSI RESONANCES
RHO-765 RESONANCES
VECTOR MESONS/STRONG INTERACTIONS
Unitary unified field theories, 3:27309
VEGETATION
See PLANTS
VEHICLES
See also AUTOMOBILES
ELECTRIC-POWERED VEHICLES
HYBRID ELECTRIC-POWERED VEHICLES
VEHICLES/FUEL ECONOMY
Diagnostic motor vehicle inspection demonstration projects, program engineering support. Volume 7. Appendix f. Fuel economy evaluation. Final report November 1974-December 1976, 3:26587 (PB-270995)
VENTILATION/PIPES
Instructions for treating internal coatings of man-sized pipes and containers, 3:26552
VERTICAL DIVESTITURE/EVALUATION
Divestiture: the pros and cons, 3:26520
VESSELS
See CONTAINERS
VESSELS (PRESSURE)
See PRESSURE VESSELS
VIRUSES
See also BACTERIOPHAGES
VIRUSES/BIOLOGICAL RADIATION EFFECTS
Characterization of an enveloped mycoplasmavirus (Ultraviolet radiation), 3:26977 (UR-3490/LCP-4)
VIRUSES/GROWTH
Characterization of an enveloped mycoplasmavirus (Ultraviolet radiation), 3:26977 (UR-3490/LCP-4)
VISIBLE RADIATION/BIOLOGICAL EFFECTS
Effect of light on respiration and development of photosynthetic cells. Progress report, June 1, 1976-August 31, 1977 (Chlamydomonas, Euglena, spinach, peas), 3:26969 (COO-3231-5)
VISIBLE RADIATION/VELOCITY
Predictions of variations of the speed of light measured by stable clocks, 3:27406
VOID COEFFICIENT/CALCULATION METHODS
Calculation of the reactivity due to bubble collapse with the probability table method (LMFBR), 3:26283 (ORNL/CSD/TM-35)

VOLCANIC ROCKS
See also LAVA
VOLCANIC ROCKS/ACTIVATION ANALYSIS
Uranium abundance in some Precambrian and Phanerozoic rocks from New Mexico, 3:25912
VOLCANIC ROCKS/AGE ESTIMATION
Chemical data and variation diagrams of igneous rocks from the Timber Mountain-Oasis Valley, Caldera Complex, southern Nevada, 3:27018 (USGS-OFR-77-724)
VOLCANIC ROCKS/CHEMICAL COMPOSITION
Chemical data and variation diagrams of igneous rocks from the Timber Mountain-Oasis Valley, Caldera Complex, southern Nevada, 3:27018 (USGS-OFR-77-724)
VOLCANOES/ERUPTION
Identification of eruption clouds with the Landsat satellites, 3:26089
VOLTAIC CELLS
See ELECTRIC BATTERIES
VRAIN REACTOR/REACTOR ACCIDENTS
High-temperature gas-cooled reactor safety studies for the Division of Reactor Safety Research. Quarterly progress report, July 1-September 30, 1977, 3:26255 (ORNL/NUREG/TM-164)

W

W BOSON
See INTERMEDIATE BOSONS
WARFARE/DATA ACQUISITION
Nuclear weapon effects uncertainties in tactical warfare. Final report, 2 June-3 Nobember 1975, 3:26854 (AD-A-043684)
WARFARE/PLANNING
Nuclear weapon effects uncertainties in tactical warfare. Final report, 2 June-3 Nobember 1975, 3:26854 (AD-A-043684)
WASHINGTON/ENERGY SOURCE DEVELOPMENT
Western States energy resource development update 1976, 3:26503
WASHINGTON/ENERGY SUPPLIES
Northwest Energy Policy Project. Energy supply and environmental impacts: conventional energy sources. Study Module III-A final report, 3:26512 (NP-23054)
WASTE DISPOSAL
See also RADIOACTIVE WASTE DISPOSAL
WASTE DISPOSAL/BIBLIOGRAPHIES
Solid waste disposal economics (a bibliography with abstracts). Report for 1964-September 1977, 3:26574 (NTIS/PS-77/0790)
WASTE HEAT UTILIZATION
Smoke tube boiler for heat recovery of hot exhaust gas, 3:26570
WASTE HEAT UTILIZATION/PLANNING
Agricultural use of heat discharge by nuclear power plants, 3:26420
WASTE OILS/RECYCLING
Waste oil fact sheet, 3:26571 (NP-22973)
WASTE OILS/RESEARCH PROGRAMS
Waste oil fact sheet, 3:26571 (NP-22973)
WASTE PROCESSING
See also ANAEROBIC DIGESTION
RADIOACTIVE WASTE PROCESSING
Detailed accident analysis for the high level waste preparation phase of the commercial nuclear waste vitrification project, 3:26989 (BNWL-2207)
WASTE PROCESSING/BIBLIOGRAPHIES
Solid waste disposal economics (a bibliography with abstracts). Report for 1964-September 1977, 3:26574 (NTIS/PS-77/0790)
WASTE PROCESSING/DEMONSTRATION PLANTS
ANFLOW treatment of municipal waste water, 3:26011 (COO/2991-19)
WASTE PROCESSING PLANTS/HEAT RECOVERY
Where does the garbage go, 3:26575 (DOE-tr-26)
WASTE SOLUTIONS
See LIQUID WASTES
WASTE WATER/CHEMICAL ANALYSIS
Environmental assessment of the HYGAS Process. Project No. 9025 monthly progress report, August 1-August 31, 1977, 3:25637 (FE-2433-18)
WASTE WATER/DECONTAMINATION
Procedure and device for decontaminating radioactive waste waters (Patent), 3:25933
WASTE WATER/SAMPLING
Environmental aspects of the HYGAS Process, 3:25624 (CONF-780305-10)
WASTE WATER/WASTE PROCESSING
ANFLOW treatment of municipal waste water, 3:26011 (COO/2991-19)
WATER
See also FEEDWATER
GROUND WATER
HEAVY WATER
SEAWATER
SURFACE WATERS
WATER/ATOM-MOLECULE COLLISIONS
Ionizing collisions of cesium and potassium atoms with water, 3:27066
WATER/CHEMICAL ANALYSIS
Determination of trace elements in soft, hard, and saline waters by the inductively coupled plasma, multi-element atomic emission spectroscopic (ICP-MAES) technique, 3:26664
WATER/CHEMICAL REACTIONS
Tracer experiments on the reaction of UH_3 in water, 3:26699 (AD-239162)
WATER/CHEMISORPTION
Evidence for the structures of adsorbed NH_3 and H_2O on RU(001), 3:25968 (AD-A-043330)
WATER/CONTAMINATION
Radionuclides in air, water, and biota (^{40}K, ^{7}Be, ^{137}Cs), 3:26934 (TID-26712)
WATER/DECONTAMINATION
Decontamination of water containing chemical and radiological warfare agents by reverse osmosis. Technical report Jul-Nov 76, 3:26933 (AD-A-046203)
WATER/DIFFUSION
Transport of liquids and gases through coatings, 3:26689
WATER/EQUILIBRIUM
Preparation of a coal conversion systems technical data book. Project 8979 quarterly report, May 1-July 31, 1977 (NH_3-CO_2-H_2S-H_2O, cyclohexane-H_2O), 3:25633 (FE-2286-20)
WATER/POLLUTION
Transport and transformation pathways of hazardous chemicals from solid waste disposal, 3:26875 (CONF-7710114-1)
WATER/RADIOLYSIS
Reactions of thiophene with radiolytically produced radicals. I. The hydroxyl radical (Electrons), 3:26695
WATER/ROCK-FLUID INTERACTIONS
Reaction of granodiorite with water at 300°C and 1/3 kb in a circulation system (abstract), 3:26121
WATER/VAPOR PRESSURE
Vapor pressure of water at its triple point: highly accurate value, 3:26116
WATER COOLED REACTORS
See also ACPR REACTOR
BWR TYPE REACTORS
KOEBERG-1 REACTOR
ORR REACTOR
PWR TYPE REACTORS
WWR TYPE REACTORS
WATER COOLED REACTORS/PRESSURE VESSELS
Structural integrity of water reactor pressure boundary components. Progress report for period ending 28 February 1977, 3:26430 (AD-A-042219)
WATER COOLED REACTORS/REACTOR COOLING SYSTEMS
Structural integrity of water reactor pressure boundary components. Progress report for period ending 28 February 1977, 3:26430 (AD-A-042219)
WATER POLLUTION/AERIAL MONITORING
Aquatic and terrestrial surveys in the vicinity of power plants using remote sensing. Final report, 3:26920 (PB-273463)
WATER QUALITY/DATA ANALYSIS
Automation of the national water quality laboratories, U.S. Geological Survey 2: design concepts for achievement of automation objectives (Computer systems), 3:27017 (UCRL-52295(Pt.2))
WATER RESOURCES/EVALUATION
Energy systems and statistics, 3:26505 (LA-6807-PR)
WATER RESOURCES/PLANNING
Water resources appraisal for hydroelectric licensing, Kern River Basin, California, 3:25978 (TID-28173)
WATER RESOURCES/USES
Water resources appraisal for hydroelectric licensing, Kern River Basin, California, 3:25978 (TID-28173)
WATERFLOODING/SURFACTANTS
Salinity tolerant surfactant oil recovery process (Patent), 3:25747
WAVE PROPAGATION/NONLINEAR PROBLEMS
Nonlinear wave and soliton propagation in media with arbitrary inhomogeneities, 3:27417
WAVES (SHOCK)
See SHOCK WAVES
WEAK BOSON
See INTERMEDIATE BOSONS
WEAK INTERACTIONS
Composite gauge fields and models, 3:27203
WEAK INTERACTIONS/COUPLING CONSTANTS
Currents, quarks, and gluons, 3:27162

WEAK INTERACTIONS/GAUGE INVARIANCE
Gauge theories of weak interactions with left-right symmetry and the structure of neutral currents, 3:27250
Super-gauge groups, 3:27204
WEAK INTERACTIONS/MEETINGS
Weak and electromagnetic interactions at high energies. Part A, 3:27292
WEAK INTERACTIONS/QUANTUM ELECTRODYNAMICS
Impact of quantum electrodynamics, 3:27255 (SLAC-PUB-1699)
WEAK INTERACTIONS/QUARK MODEL
Gauge theories of weak interactions with left-right symmetry and the structure of neutral currents, 3:27250
WEAK NEUTRAL CURRENTS/FLAVOR MODEL
Flavor conservation in an SU(3) x U(1) x U(1) model, 3:27198
WELDED JOINTS
Device for welding pipes onto pressurized elements, like tube sheets, pressure vessels, headers and the like (Patent), 3:26380
WELDS
See WELDED JOINTS
WELL CASINGS/SEALS
Geologo-technical efficiency of rising thermometry and radioisotopes in investigation of pumping wells in Tataria, 3:25763
WELL DRILLING/DRILL PIPES
Problem of stability of drill pipe strings, 3:25755
Spiral deformation of a pipe string in a directional well, 3:25754
WELL DRILLING/DRILLING EQUIPMENT
Suction sticking of drilling tools, 3:25756
WELL DRILLING/DRILLING FLUIDS
Investigation of the cake formation process under static filtration conditions, 3:25757
WELL STIMULATION/RESEARCH PROGRAMS
Evaluation of methods for stimulation and characterzation of eastern gas shales. Progress report, April-June 1977, 3:25859 (LA-7094-PR)
WELLS
See also GEOTHERMAL WELLS
NATURAL GAS WELLS
OIL WELLS
WELLS/PLUGGING
Seismic drill hole surface plug (Patent), 3:26713
WESTINGHOUSE STANDARD REACTOR
(Prior to 1975, PWR/41 TYPE REACTORS was used.)
Westinghouse seeks minimum costs with maximum reliability, 3:26242
WEYL UNIFIED THEORY
Recent developments in nonlinear spinor theories (Subcanonical fields with dimension $1/2$), 3:27306
WHISTLERS/MODULATION
Two-dimensional self-modulation of a whistler wave propagating along the magnetic field in a plasma, 3:27580
WHOLE-BODY COUNTERS/CALIBRATION
Realistic calibration of whole body counters for measuring plutonium, 3:26817 (IAEA-SM-222/57)
WILD ANIMALS/FOOD CHAINS
^{239}Pu and ^{241}Am contamination of small vertebrates in NAEG study areas of NTS and TTR, 3:26915 (NVO-171)
WILD ANIMALS/LEGAL ASPECTS
History, 1741-1967, 3:26922 (TID-26712)
WILD ANIMALS/RADIONUCLIDE KINETICS
^{239}Pu and ^{241}Am contamination of small vertebrates in NAEG study areas of NTS and TTR, 3:26915 (NVO-171)
Applications to waste management operations (Terrestrial ecosystems), 3:25951 (PNL-2253)
WILD ANIMALS/RESOURCE CONSERVATION
Sea mammals: resources and population, 3:26938 (TID-26712)
WIND/ENVIRONMENTAL EFFECTS
Estimation of air concentrations due to the diffusion, deposition and resuspension of contaminants by the wind, 3:26883 (PNL-2426)
WIND/MATHEMATICAL MODELS
Three velocity component, nonhomogeneous atmospheric boundary-layer turbulence modeling, 3:27031
WIND/TURBULENCE
Three velocity component, nonhomogeneous atmospheric boundary-layer turbulence modeling, 3:27031
WIND POWER/REVIEWS
Windpower, 3:26127
WIND TURBINES/COST
Wind power for india, 3:26125
WIND TURBINES/ENERGY EFFICIENCY
Windpower, 3:26127
WIND TURBINES/MECHANICAL STRUCTURES
Approximate method for calculating free vibrations of a large-wind-turbine tower structure, 3:26126 (ERDA/NASA/1028-77/12)
WIND TURBINES/SITE SELECTION
Wind power for india, 3:26125
WINDOWS/SPECTRALLY SELECTIVE SURFACES
Wavelength-selective surfaces for solar energy utilization, 3:26070
WINDOWS/THERMAL INSULATION
Wavelength-selective surfaces for solar energy utilization, 3:26070
WINSTON COLLECTORS
See COMPOUND PARABOLIC CONCENTRATORS
WOOD/COMBUSTION
Solar biomass energy: an overview of U.S. potential, 3:26027
WORKERS
See PERSONNEL
WWER TYPE REACTORS/REACTOR COOLING SYSTEMS
Radioanalysis of water circuit at nuclear power plants, 3:26249
WWER TYPE REACTORS/WATER CHEMISTRY
Chemical process measurements in PWR-type nuclear power plants, 3:26229
WWR TYPE REACTORS
Experimental water-water reactor (Patent), 3:26428
WYOMING/ENERGY SOURCE DEVELOPMENT
Western States energy resource development update 1976, 3:26503
WYOMING/NATURAL GAS DEPOSITS
Petroleum potential of southwestern Wyoming and adjacent areas, 3:25737
Shallow marine deposits in the Upper Cretaceous Pierre Shale of the northern Denver basin and their relation to hydrocarbon accumulation, 3:25739
WYOMING/OIL SHALE DEPOSITS
Oil shale and the environment, 3:25902 (EPA-600/9-77-033)
WYOMING/PETROLEUM DEPOSITS
Biostratigraphic correlation of the Mesaverde Group in southwestern Wyoming and northwestern Colorado, 3:25736
Petroleum potential of southwestern Wyoming and adjacent areas, 3:25737
Preliminary report: petroleum geochemistry of the Denver basin, 3:25741
Shallow marine deposits in the Upper Cretaceous Pierre Shale of the northern Denver basin and their relation to hydrocarbon accumulation, 3:25739
WYOMING/URANIUM DEPOSITS
Geology of uranium deposits in the Madison Limestone Little Mountain area, Big Horn County, Wyoming, 3:25910

X

2X DEVICES/DRIFT INSTABILITY
Radial normal mode calculation of warm plasma stabilization of the drift cone mode, 3:27544
X RADIATION/BIOLOGICAL RADIATION EFFECTS
Procedures for the detection of unscheduled DNA synthesis in the germ cells of mole mice exposed in vivo to chemical mutagens (^{3}H-dt tracer study), 3:26996 (TID-28142)
X RADIATION/ENERGY LOSSES
Coupling of x-ray deposition to structural response. Final report, 3:27398 (AD-A-042667)
XI-1630 RESONANCES/PARTICLE PRODUCTION
Search for Ξ^* production in K^-p interactions at 2.87 GeV/c, 3:27140
XI-1820 RESONANCES/PARTICLE PRODUCTION
Search for Ξ^* production in K^-p interactions at 2.87 GeV/c, 3:27140
XI-1930 RESONANCES/PARTICLE PRODUCTION
Search for Ξ^* production in K^-p interactions at 2.87 GeV/c, 3:27140
X-RAY DOSIMETRY/THERMOLUMINESCENT DOSEMETERS
Photon and beta response of a new thermoluminescent dosimeter badge, 3:26824 (LA-UR-77-3001)
X-RAY LASERS/OPTICAL PUMPING
Opportunities to produce coherent soft x-rays at Stanford, 3:26740 (RLO/2230/T4-191)
Possibility of coherent hard x-ray production by pumping with synchrotron radiation and low energy photons. Period covered: November 17, 1976-August 16, 1977, 3:26741 (RLO/2230/T5-192)
X-RAY RADIOGRAPHY/RESOLUTION
High resolution time resolvable flash x-radiography system, 3:27670 (SAND-77-1587C)
X-RAY SOURCES
See also COSMIC X-RAY SOURCES
X-RAY SOURCES/FEASIBILITY STUDIES
Opportunities to produce coherent soft x-rays at Stanford, 3:26740 (RLO/2230/T4-191)
Possibility of coherent hard x-ray production by pumping with synchrotron radiation and low energy photons. Period covered: November 17, 1976-August 16, 1977, 3:26741 (RLO/2230/T5-192)

X-RAY SOURCES/LASER-RADIATION HEATING
Laser heating of magnetically confined plasmas for x-ray production. Final report on phase 3, 3:27481 (AD-A-043486)
X-RAY SOURCES/PERFORMANCE
Laser heating of magnetically confined plasmas for x-ray production. Final report on phase 3, 3:27481 (AD-A-043486)
X-RAY SPECTROSCOPY
Recent advances in analytical electron microscopy, 3:26662 (CONF-770504-)
XYLOSE/FERMENTATION
Study of the fermentation of xylose to ethanol by fusarium oxysporum, 3:26022 (LBL-6351)
X-ZERO RESONANCES
See ETA-958 RESONANCES

Y

YANG-MILLS THEORY/ANGULAR MOMENTUM
Angular momentum in non-Abelian gauge field theories, 3:27290
YANG-MILLS THEORY/DUALITY
Multidimensional method of the inverse scattering problem and duality equations for the Yang-Mills field, 3:27285
YANG-MILLS THEORY/EUCLIDEAN SPACE
Pseudoparticle parameters for arbitrary gauge groups, 3:27242
YANG-MILLS THEORY/HADRON-HADRON INTERACTIONS
Gauge fields and strong interactions (Lectures), 3:27212
YANG-MILLS THEORY/INFRARED DIVERGENCES
Near-mass-shell infrared behavior of non-Abelian gauge theories and the renormalization group, 3:27279
YANG-MILLS THEORY/INFRARED RADIATION
Fermionic representation of the infrared behavior of pure Yang-Mills fields, 3:27289
YANG-MILLS THEORY/INVERSE SCATTERING PROBLEM
Multidimensional method of the inverse scattering problem and duality equations for the Yang-Mills field, 3:27285
YANG-MILLS THEORY/MINKOWSKI SPACE
Classical solution of the Yang-Mills equations in Minkowski space, 3:27264
YANG-MILLS THEORY/O GROUPS
How to compute determinants compactly, 3:27278
Yang-Mills theory on the hypertorus, 3:27267
YANG-MILLS THEORY/RENORMALIZATION
Near-mass-shell infrared behavior of non-Abelian gauge theories and the renormalization group, 3:27279
YANG-MILLS THEORY/SU-2 GROUPS
Pseudoparticle parameters for arbitrary gauge groups, 3:27242
YEASTS/BIOCHEMICAL REACTION KINETICS
Yeast mitochondrial DNA specifies tRNA for 19 amino acids. Deletion mapping of the tRNA genes, 3:26950
YEASTS/BIOCHEMISTRY
Spin label studies on membranes and the aqueous zones of membrane enclosures. Progress report, period covered: August 1976 to the present, 3:26959 (COO-2223-25)
YTTERBIUM 168 TARGET/ALPHA REACTIONS
Coulomb excitation measurements of reduced E2 and E4 transition matrix elements in ^{156,158}Dy, ^{162,164}Er, and ^{168}Yb, 3:27374
YTTERBIUM 170/MOESSBAUER EFFECT
Breakdown of the "white noise approximation" in the Moessbauer relaxation spectra: The case of $Cs_2NaYbCl_6$, 3:26653
YTTERBIUM CHLORIDES/CRYSTAL STRUCTURE
Breakdown of the "white noise approximation" in the Moessbauer relaxation spectra: The case of $Cs_2NaYbCl_6$, 3:26653
YTTERBIUM COMPOUNDS/KNIGHT SHIFT
Systematics in the Knight shift of rare-earth monopnictides, 3:26600
YTTERBIUM FLUORIDES/EMISSION SPECTRA
Infrared-to-visible conversion in (Y, Yb, Er)F_3 and (Y, Yb, Ho)F_3, 3:26648
YTTRIUM/ION EXCHANGE
Cation exchange of 53 elements in nitric acid, 3:26665 (LA-7083)
YTTRIUM 89/ENERGY-LEVEL DENSITY
High resolution neutron total cross section measurement of ^{89}Y, 3:27366
YTTRIUM 89/GIANT RESONANCE
Investigation of giant multipole resonances in medium and heavy nuclei by inelastic electron scattering. Final technical report, 15 October 1974-31 October 1976, 3:27356 (AD-A-042298)
YTTRIUM 89 TARGET/ELECTRON REACTIONS
Investigation of giant multipole resonances in medium and heavy nuclei by inelastic electron scattering. Final technical report, 15 October 1974-31 October 1976, 3:27356 (AD-A-042298)
YTTRIUM 89 TARGET/NEUTRON REACTIONS
Cross sections for (n,2n) and (n,3n) reactions above 14 MeV, 3:27353
Equilibrium, pre-equilibrium, and direct processes in the (n,n') reaction, 3:27354
High resolution neutron total cross section measurement of ^{89}Y, 3:27366
YTTRIUM 89 TARGET/PROTON REACTIONS
Anomalous optical-model potential for sub-Coulomb protons for $89 < A < 130$, 3:27361
YTTRIUM ALLOYS/ELECTRIC CONDUCTIVITY
Scattering of conduction electrons by spin disorder in rare-earth dysprosium-yttrium alloys, 3:26625
YTTRIUM FLUORIDES/EMISSION SPECTRA
Infrared-to-visible conversion in (Y, Yb, Er)F_3 and (Y, Yb, Ho)F_3, 3:26648
YTTRIUM OXIDES/ELECTRIC CONDUCTIVITY
Specific electrical conductivity of liquid yttrium oxide at high temperatures, 3:26639
YTTRIUM OXIDES/MECHANICAL PROPERTIES
Ceramic technology readiness program. Third monthly technical progress report, November 28, 1977-January 1, 1978, 3:26144 (FE/2664-3)
YTTRIUM OXIDES/PHOTOLUMINESCENCE
Characteristics of the excitation of Al_2O_3-Eu and Y_2O_3-Eu surface luminescence centers, 3:26640
YTTRIUM OXIDES/PHYSICAL PROPERTIES
Ceramic technology readiness program. Third monthly technical progress report, November 28, 1977-January 1, 1978, 3:26144 (FE/2664-3)

Z

ZARNOWIEC REACTOR/RADIOACTIVE EFFLUENTS
Some characteristics of the first Polish atomic power station relating to its effect on the environment, 3:26418
ZARNOWIEC REACTOR/THERMAL EFFLUENTS
Some characteristics of the first Polish atomic power station relating to its effect on the environment, 3:26418
ZEOLITES/CATALYTIC EFFECTS
Hydrogenation of hexene over platinum on alumina vs. platinum in a Na-Y zeolite, 3:26684
ZEOLITES/CHEMICAL RADIATION EFFECTS
Trapping and stabilization of hydrogen atoms in intracrystalline voids. Defected calcium fluorides and Y zeolite surfaces (γ rays), 3:26698
ZINC/AUGER EFFECT
Configuration-interaction effects on the L and M Auger spectra of Cu and Zn, 3:27049
ZINC/EMISSION SPECTROSCOPY
Determination of trace elements in soft, hard, and saline waters by the inductively coupled plasma, multi-element atomic emission spectroscopic (ICP-MAES) technique, 3:26664
ZINC/ENVIRONMENTAL TRANSPORT
Corrections and revisions to the FORTRAN IV version of the Wisconsin Hydrologic Transport Model, 3:27003 (ORNL/NSF/EATC-29)
ZINC/ION EXCHANGE
Cation exchange of 53 elements in nitric acid, 3:26665 (LA-7083)
ZINC 64/HIGH SPIN STATES
High-spin states in ^{64}Zn, 3:27357
ZINC ALLOYS/CORROSION PROTECTION
Protection of steel and zinc-alloyed steel in power plants with Goldschmidt-products, 3:26186
ZINC CHLORIDES/CATALYTIC EFFECTS
Zinc halide hydrocracking process for distillate fuels from coal. Monthly technical progress report, November 1977, 3:25651 (FE-1743-46)
ZINC CHLORIDES/RECOVERY
Zinc halide hydrocracking process for distillate fuels from coal. Monthly technical progress report, November 1977, 3:25651 (FE-1743-46)
ZINC HALIDE PROCESS/PROCESS DEVELOPMENT UNITS
Zinc halide hydrocracking process for distillate fuels from coal. Monthly technical progress report, November 1977, 3:25651 (FE-1743-46)
ZINC-AIR BATTERIES/RESEARCH PROGRAMS
Federal battery program for transportation uses, 3:26485 (CONF-7606127-1)
ZIRCALOY/MECHANICAL PROPERTIES
Response of unirradiated and irradiated PWR fuel rods tested under power-cooling-mismatch conditions, 3:26443 (TREE-NUREG-1196)

ZIRCALOY 4/YIELD STRENGTH
Application of finite element method to ring compression test, 3:26387
ZIRCONIUM/ION EXCHANGE
Cation exchange of 53 elements in nitric acid, 3:26665 (LA-7083)
ZIRCONIUM CARBIDES/SPECIFIC HEAT
Thermophysical properties of cubic carbides of zirconium and niobium at high temperatures, 3:26615
ZIRCONIUM CARBIDES/THERMAL DIFFUSIVITY
Thermophysical properties of cubic carbides of zirconium and niobium at high temperatures, 3:26615
ZIRCONIUM CHLORIDES/CHEMICAL COMPOSITION
Metal-metal bonded clusters in transition metal groups 3 and 4. Synthesis and structure of three M_6X_{12}-type clusters for scandium and zirconium, 3:26677
ZIRCONIUM CHLORIDES/CRYSTAL STRUCTURE
Metal-metal bonded clusters in transition metal groups 3 and 4. Synthesis and structure of three M_6X_{12}-type clusters for scandium and zirconium, 3:26677
ZIRCONIUM COMPOUNDS/MAGNETIC RESONANCE
Optical and zero field magnetic resonance spectroscopy of inorganic molecular solids. Final report, 1 June 1975-31 May 1977, 3:26645 (AD-A-043340)
ZIRCONIUM COMPOUNDS/OPTICAL PROPERTIES
Optical and zero field magnetic resonance spectroscopy of inorganic molecular solids. Final report, 1 June 1975-31 May 1977, 3:26645 (AD-A-043340)
ZIRCONIUM IODIDES/CHEMICAL COMPOSITION
Metal-metal bonded clusters in transition metal groups 3 and 4. Synthesis and structure of three M_6X_{12}-type clusters for scandium and zirconium, 3:26677
ZIRCONIUM IODIDES/CRYSTAL STRUCTURE
Metal-metal bonded clusters in transition metal groups 3 and 4. Synthesis and structure of three M_6X_{12}-type clusters for scandium and zirconium, 3:26677
ZIRCONIUM OXIDES/EMISSIVITY
Infrared emissivities of micron-sized particles of C, MgO, Al_2O_3, and ZrO_2. Final report, 3:26636 (AD-A-042144)
ZIRCONIUM OXIDES/MECHANICAL PROPERTIES
Ceramic technology readiness program. Third monthly technical progress report, November 28, 1977-January 1, 1978, 3:26144 (FE/2664-3)
ZIRCONIUM OXIDES/PHYSICAL PROPERTIES
Ceramic technology readiness program. Third monthly technical progress report, November 28, 1977-January 1, 1978, 3:26144 (FE/2664-3)

CONTRACT NUMBER INDEX

Numbers assigned to DOE contracts under which reports announced in this publication were prepared are included in this index.

Contract No.	*Abstract No.*	*Report No.*
EC-77-C-01-5053	**Society of Automotive Engineers, Inc., Warrendale, Pa. (USA)**	
	3:26579	CONS/5053—1
EC-77-S-05-5468	**Oklahoma Univ., Norman (USA)**	
	3:26524	ORO/5468—1
EC-78-C-01-4131	**Alabama Univ., Huntsville (USA). Kenneth E. Johnson Environmental and Energy Center**	
	3:26044	CONF-771229—(Summ.)
EE-77-S-02-4268	**Sloan-Kettering Inst. for Cancer Research, New York (USA)**	
	3:26971	COO/4268—1
EE-77-S-02-4427	**Bituminous Coal Research, Inc., Monroeville, Pa. (USA)**	
	3:25707	COO/4427—1
EF-76-C-01-2335	**Engelhard Minerals and Chemicals Corp., Murray Hill, N.J. (USA). Engelhard Industries Div.**	
	3:25658	FE—2335-16
EF-76-C-01-2564	**New England Power Service Co., Westborough, Mass. (USA)**	
	3:25714	FE—2564-9
	3:25715	FE—2564-10
EF-77-A-01-2565	**Bechtel Corp., San Francisco, Calif. (USA)**	
	3:25639	FE—2565-10
EF-77-A-01-2893	**Exxon Research and Engineering Co., Florham Park, N.J. (USA)**	
	3:25660	FE—2893-6
EF-77-C-01-2468	**Engineering Societies Commission on Energy, Inc., Washington, D.C. (USA)**	
	3:25638	FE—2468-18
EF-77-C-01-2556	**Solar Turbines International, San Diego, Calif. (USA)**	
	3:26152	FE—2556-09
EF-77-C-01-2588	**Amoco Oil Co., Naperville, Ill. (USA). Research and Development Dept.**	
	3:25659	FE—2588-4
EF-77-C-01-2611	**AiResearch Mfg. Co. of Arizona, Phoenix (USA)**	
	3:26149	TID—28200
EF-77-C-01-2615	**Mechanical Technology, Inc., Latham, N.Y. (USA)**	
	3:25640	MIT—78-TR3
EF-77-C-01-2621	**International Nickel Co., Inc., Suffern, N.Y. (USA). Paul D. Merica Research Lab.**	
	3:25643	TID—28187
EF-77-C-01-2664	**AiResearch Mfg. Co. of Arizona, Phoenix (USA)**	
	3:26144	FE/2664—3
EG-76-G-03-1426	**Houston Univ., Tex. (USA). Solar Energy Lab.**	
	3:26034	ORO/5178—78-1
EG-77-C-01-4017	**George Washington Univ., Washington, D.C. (USA). School of Engineering and Applied Science**	
	3:26047	DSE/4017—1
EG-77-C-04-3989	**TRW Energy Systems Group, Redondo Beach, Calif. (USA)**	
	3:26039	TID—28013
EG-77-S-02-4511	**Colorado State Univ., Fort Collins (USA). Solar Energy Applications Lab.**	
	3:26046	COO/4511—2
EM-75-C-01-8403	**Gordian Associates, Inc., New York (USA)**	
	3:26531	HCP/L50172—01
	3:26532	HCP/L50172—02
EN-77-C-01-2644	**Booz, Allen and Hamilton, Inc., Bethesda, Md. (USA)**	
	3:26332	TID—28078
ES-77-A-01-6021	**Naval Research Lab., Washington, D.C. (USA)**	
	3:27669	NRL-MR—3669
EX-76-A-29-1028	**National Aeronautics and Space Administration, Cleveland, Ohio (USA). Lewis Research Center**	
	3:26126	ERDA/NASA/1028—77/12
EX-76-A-29-1060	**Jet Propulsion Lab., Pasadena, Calif. (USA)**	
	3:26038	DOE/JPL/1060—1
EX-76-A-29-1060-003	**National Aeronautics and Space Administration, Cleveland, Ohio (USA). Lewis Research Center**	
	3:26061	ERDA/NASA/1060—77/1
EX-76-A-31-1011	**National Aeronautics and Space Administration, Cleveland, Ohio (USA). Lewis Research Center**	
	3:26578	CONS/1011—22
	3:26580	HCP/M1011—01
EX-76-C-01-1207	**Bituminous Coal Research, Inc., Monroeville, Pa. (USA)**	
	3:25627	FE—1207-40
EX-76-C-01-1216	**National Academy of Sciences - National Research Council, Washington, D.C. (USA)**	
	3:25661	FE/1216—2
EX-76-C-01-1514	**Westinghouse Electric Corp., Lester, Pa. (USA). Generation Systems Div.**	
	3:25628	FE—1514-73
EX-76-C-01-1517	**Fluor Engineers and Constructors, Inc., Irvine, Calif. (USA)**	
	3:25649	FE—1517-55
	3:25650	FE—1517-58
EX-76-C-01-1545	**Combustion Engineering, Inc., Windsor, Conn. (USA)**	
	3:25629	FE—1545-39
EX-76-C-01-1743	**Conoco Coal Development Co., Library, Pa. (USA). Research Div.**	
	3:25651	FE—1743-46
EX-76-C-01-1806	**General Electric Co., Schenectady, N.Y. (USA). Gas Turbine Div.**	
	3:26141	FE—1806-20
EX-76-C-01-2035	**Colorado School of Mines, Golden (USA). Dept. of Chemical and Petroleum Refining Engineering**	
	3:25652	FE—2035-10
EX-76-C-01-2047	**Colorado School of Mines, Golden (USA)**	
	3:25665	TID—28167
EX-76-C-01-2202	**SRI International, Menlo Park, Calif. (USA)**	
	3:25653	FE—2202-21
EX-76-C-01-2240	**Braun (C.F.) and Co., Alhambra, Calif. (USA)**	
	3:25631	FE—2240-79
EX-76-C-01-2244	**Occidental Research Corp., La Verne, Calif. (USA)**	
	3:25654	FE—2244-15

Contract No.	Abstract No.	Report No.
EX-76-C-01-2246	**Mississippi State Univ., Mississippi State (USA). Energy Research Center**	
	3:26538	FE—2246-3(Rev.A)
EX-76-C-01-2247	**Texaco, Inc., Montebello, Calif. (USA). Montebello Research Lab.**	
	3:25632	FE—2247-9R
EX-76-C-01-2260	**Ashland Synthetic Fuels, Inc., Ky. (USA)**	
	3:25655	FE—2260-16
EX-76-C-01-2286	**Institute of Gas Technology, Chicago, Ill. (USA)**	
	3:25615	FE—2286-25
	3:25633	FE—2286-20
EX-76-C-01-2295-018	**Massachusetts Inst. of Tech., Cambridge (USA). Energy Lab.**	
	3:26145	MIT—2295-T18-3
	3:26146	MIT—2295-T18-4
EX-76-C-01-2295-026	**Massachusetts Inst. of Tech., Cambridge (USA)**	
	3:25619	FE-MIT—2295T26-3
EX-76-C-01-2307	**Institute of Gas Technology, Chicago, Ill. (USA)**	
	3:25656	FE—2307-25
EX-76-C-01-2335	**Engelhard Minerals and Chemicals Corp., Edison, N.J. (USA). Engelhard Industries Div.**	
	3:25657	FE—2335-13
EX-76-C-01-2336	**Institute of Gas Technology, Chicago, Ill. (USA)**	
	3:25634	FE—2336-17
EX-76-C-01-2343	**Booz, Allen and Hamilton, Inc., Bethesda, Md. (USA). Booz, Allen Applied Research Div.**	
	3:26780	FE/2343—1
EX-76-C-01-2357	**General Electric Co., Schenectady, N.Y. (USA). Energy Systems Programs Dept.**	
	3:26142	FE—2357-19
EX-76-C-01-2371	**Burns and Roe Industrial Services Corp., Paramus, N.J. (USA)**	
	3:26143	FE—2371-20
EX-76-C-01-2408	**Carnegie-Mellon Univ., Pittsburgh, Pa. (USA)**	
	3:25681	FE—2408-5
EX-76-C-01-2433	**Institute of Gas Technology, Chicago, Ill. (USA)**	
	3:25636	FE—2433-17
	3:25637	FE—2433-18
EX-76-C-01-2435	**Institute of Gas Technology, Chicago, Ill. (USA)**	
	3:25961	FE—2435-16
EX-76-C-01-2473	**Combustion Engineering, Inc., Windsor, Conn. (USA)**	
	3:26779	FE—2473-15
EX-76-C-01-2489	**Institute of Gas Technology, Chicago, Ill. (USA)**	
	3:25712	FE—2489-18
EX-76-C-01-2538	**Delaware Univ., Newark (USA). Inst. of Energy Conversion**	
	3:25989	DSE/2538—1
	3:25996	TID—28183
EX-76-C-02-2857	**Public Service Electric and Gas Co., Newark, N.J. (USA)**	
	3:26522	HCP/T2857—1
EX-76-C-12-2218	**Babcock and Wilcox Co., Lynchburg, Va. (USA)**	
	3:25630	FE—2218-15
EX-76-C-16-3066	**General Electric Co., Philadelphia, Pa. (USA). Space Div.**	
	3:25956	GESP—7134
EX-76-S-01-2340	**City Coll., New York (USA)**	
	3:25635	FE—2340-4
EX-76-S-01-2516	**Lehigh Univ., Bethlehem, Pa. (USA)**	
	3:25713	FE—2516-4
EY-76--02-2456	**Columbia Univ., New York (USA). School of Engineering and Applied Science**	
	3:27502	COO—2456-52
EY-76-A-08-0474	**Geological Survey, Washington, D.C. (USA)**	
	3:27018	USGS-OFR—77-724
EY-76-C-02-0016	**Brookhaven National Lab., Upton, N.Y. (USA)**	
	3:25710	BNL—23765
	3:26670	BNL—23550
	3:26777	BNL—50644
	3:26795	BNL—23655
	3:26799	BNL—23652
	3:26800	BNL—23653
	3:26801	BNL—23654
	3:26804	BNL—23532
	3:26805	BNL—23533
	3:26806	BNL—23534
	3:26807	BNL—23535
	3:26808	BNL—23536
	3:26809	BNL—23538
	3:26810	BNL—23539
	3:26871	BNL—23579
	3:26872	BNL—23672
	3:26967	BNL—23558
	3:27057	BNL—23394
	3:27106	BNL—23513
	3:27136	BNL—23612
	3:27313	BNL-NCS—50717
	3:27338	BNL—23461
EY-76-C-02-1717	**Ohio Univ., Athens (USA)**	
	3:26788	COO—1717-9
EY-76-C-02-2272	**Wisconsin Univ., Madison (USA). Dept. of Nuclear Engineering**	
	3:27640	UWFDM—225
EY-76-C-02-2769	**Wormser Scientific Corp., Stamford, Conn. (USA)**	
	3:26045	COO/2769—2
EY-76-C-02-2835	**Mechanical Technology, Inc., Latham, N.Y. (USA)**	
	3:26582	COO/2835—1
	3:26585	MTI—78TR11
EY-76-C-02-2857	**Department of Energy, Washington, D.C. (USA). Div. of Electric Energy Systems**	
	3:26489	DOE/EA—0001
EY-76-C-02-2930	**Honeywell, Inc., Minneapolis, Minn. (USA). Systems and Research Center**	
	3:26060	COO—2930-12
EY-76-C-02-2991	**Dynatech R/D Co., Cambridge, Mass. (USA)**	
	3:26005	COO/2991—19
EY-76-C-02-3069	**Stanford Linear Accelerator Center, Calif. (USA)**	
	3:27216	SLAC-PUB—1774
	3:27226	COO—3069-556
EY-76-C-02-3073	**Princeton Univ., N.J. (USA). Plasma Physics Lab.**	
	3:27436	PPPL—1416
	3:27469	PPPL—1379
	3:27470	TID—27931
	3:27507	PPPL—1411
	3:27638	PPPL-EPRI—7
EY-76-C-02-3130	**Brown Univ., Providence, R.I. (USA). Dept. of Physics**	
	3:27146	COO—3130TA-340
EY-76-C-02-3490	**Rochester Univ., N.Y. (USA)**	
	3:26694	UR/3490/LCP—6
	3:26976	UR—3490/LCP-2
	3:26977	UR—3490/LCP-4
EY-76-C-03-0012	**California Univ., Los Angeles (USA). Lab. of Nuclear Medicine and Radiation Biology**	
	3:26993	UCLA—12-1142
EY-76-C-03-0167-017	**General Atomic Co., San Diego, Calif. (USA)**	
	3:26254	GA-A—14034
EY-76-C-03-0167-038	**Los Alamos Scientific Lab., N.Mex. (USA)**	
	3:27648	GA-A—14614(Vol.11)
	3:27701	GA-A—14614(Vol.8)
EY-76-C-03-0167-051	**General Atomic Co., San Diego, Calif. (USA)**	
	3:26434	GA-A—14592
EY-76-C-03-0515	**Stanford Linear Accelerator Center, Calif. (USA)**	
	3:27216	SLAC-PUB—1774
	3:27390	SLAC—203
EY-76-C-03-0700	**Liquid Metal Engineering Center, Canoga Park, Calif. (USA)**	
	3:26284	TID—28094
EY-76-C-03-0824	**Atomics International Div., Canoga Park, Calif. (USA)**	
	3:26274	AI-DOE—13208
	3:26276	AI-DOE—13216
EY-76-C-03-0824-012	**Atomics International Div., Canoga Park, Calif. (USA)**	
	3:26275	AI-DOE—13211
EY-76-C-03-0893-013	**General Electric Co., Sunnyvale, Calif. (USA). Fast Breeder Reactor Dept.**	
	3:26357	GEFR-SP—050
	3:26435	GEFR-SP—049

Contract No.	Abstract No.	Report No.
EY-76-C-03-1111	**Boeing Engineering and Construction, Seattle, Wash. (USA)**	
	3:26035	SAN/1111—76-7
EY-76-C-03-1223	**Resource Planning Associates, Inc., Washington, D.C. (USA)**	
	3:26509	HCP/M1223—1
EY-76-C-04-0053	**Mound Lab., Miamisburg, Ohio (USA)**	
	3:26666	MLM—2490
EY-76-C-04-0487	**Mason and Hanger-Silas Mason Co., Inc., Amarillo, Tex. (USA)**	
	3:26838	MHSMP—77-50
EY-76-C-04-0613	**Bendix Corp., Kansas City, Mo. (USA)**	
	3:26736	BDX—613-1907
	3:26845	BDX—613-1668(Rev.)
EY-76-C-04-0789	**Sandia Labs., Albuquerque, N.Mex. (USA)**	
	3:25663	SAND—77-1558C
	3:25664	SAND—77-1560C
	3:25954	SAND—77-1367
	3:25962	SAND—77-8296
	3:25995	SAND—77-1269C
	3:26033	SAND—77-8278
	3:26062	SAND—77-1466C
	3:26358	SAND—77-0533C
	3:26424	SAND—77-1807
	3:26483	SAND—77-8665
	3:26632	SAND—782076C
	3:26775	SAND—77-2035
	3:26841	SAND—77-0841
	3:26859	SAND—77-8291
	3:26985	SAND—77-1352C
	3:27670	SAND—77-1587C
	3:27706	SAND—77-1179
	3:27707	SAND—77-1684C
	3:27708	SAND—77-1831
EY-76-C-04-3533	**National Bureau of Standards, Washington, D.C. (USA)**	
	3:25953	RFP—2634
	3:26667	RFP—2716
	3:26839	RFP—2558
	3:26840	RFP—2627
EY-76-C-05-0033	**Oak Ridge Associated Universities, Inc., Tenn. (USA)**	
	3:26868	ORAU/IEA(M)—75-3
	3:26893	ORAU—129
EY-76-C-06-1830	**Battelle Human Affairs Research Center, Seattle, Wash. (USA)**	
	3:25935	BNWL—1997
	3:26442	PNL—2417
	3:26496	BNWL-RAP—16
	3:26826	PNL—2276
	3:26873	BNWL—2219
	3:26883	PNL—2426
	3:26908	PNL—2454
	3:26939	BNWL—2395
	3:26989	BNWL—2207
	3:26992	PNL—2439
EY-76-C-06-2130	**Battelle Pacific Northwest Labs., Richland, Wash. (USA)**	
	3:25943	PNL—2253
EY-76-C-07-1570	**SEE CODE- 9502158 EG and G Idaho, Inc., Idaho Falls (USA). Idaho National Engineering Lab.**	
	3:26228	LTR—10-2B
	3:26443	TREE-NUREG—1196
EY-76-C-09-0001	**Du Pont de Nemours (E.I.) and Co., Aiken, S.C. (USA). Savannah River Lab.**	
	3:25928	DPST—75-426-TL
	3:25936	DP-MS—77-115
	3:26887	DP-MS—77-41
	3:26894	SRO-NERP—1
EY-76-C-14-2170	**Hanford Engineering Development Lab., Richland, Wash. (USA)**	
	3:26282	HEDL—6297
	3:26661	HEDL-SA—1258
EY-76-S-01-1478	**Michigan Univ., Ann Arbor (USA)**	
	3:27537	CONF-771136—25
EY-76-S-02-2223	**ASEA, Inc., White Plains, N.Y. (USA)**	
	3:26959	COO—2223-25
EY-76-S-02-2245	**Massachusetts Inst. of Tech., Cambridge (USA). Dept. of Nuclear Engineering**	
	3:26279	COO—2245-35TR
	3:26280	COO—2245-37TR
	3:26281	COO—2245-40TR
	3:26405	COO—2245-47TR
EY-76-S-02-2272	**Wisconsin Univ., Madison (USA). Dept. of Nuclear Engineering**	
	3:27618	UWFDM—202
	3:27619	UWFDM—205
	3:27620	UWFDM—208
EY-76-S-02-2641	**Carnegie-Mellon Univ., Pittsburgh, Pa. (USA)**	
	3:26040	COO/2641—3
EY-76-S-02-2874	**Stanford Univ., Calif. (USA). Dept. of Statistics**	
	3:26876	COO—2874-16
EY-76-S-02-3110	**Institute for Cancer Research, Philadelphia, Pa. (USA)**	
	3:26960	COO—3110-28
EY-76-S-02-3158	**Cornell Univ., Ithaca, N.Y. (USA)**	
	3:27055	COO—3158-55
EY-76-S-02-3162	**Cornell Univ., Ithaca, N.Y. (USA)**	
	3:26945	COO—3162-36
EY-76-S-02-3231	**Brandeis Univ., Waltham, Mass. (USA)**	
	3:26969	COO—3231-5
EY-76-S-02-3264	**Jackson Lab., Bar Harbor, Maine (USA)**	
	3:26987	COO—3264-16
EY-76-S-02-3277	**Johns Hopkins Univ., Baltimore, Md. (USA). McCollum-Pratt Inst.**	
	3:26946	COO—3277-44
EY-76-S-02-3497	**Rochester Univ., N.Y. (USA)**	
	3:27538	COO—3497-24
EY-76-S-02-3501	**Rochester Univ., N.Y. (USA). School of Medicine and Dentistry**	
	3:26984	TID—28055
EY-76-S-02-3566	**Woods Hole Oceanographic Institution, Mass. (USA)**	
	3:26930	COO—3566-19
EY-76-S-02-4121	**Ohio State Univ., Columbus (USA). Dept. of Botany and Plant Pathology**	
	3:26202	COO/4121—2(Vol.1)
EY-76-S-03-036	**Stanford Linear Accelerator Center, Calif. (USA)**	
	3:26796	SLAC-PUB—1805
EY-76-S-03-0326	**Stanford Linear Accelerator Center, Calif. (USA)**	
	3:26797	SLAC-PUB—1948
	3:26813	SLAC-PUB—1971
	3:26814	SLAC-PUB—2045
	3:26815	SLAC-PUB—2053
	3:26820	SLAC-PUB—1768
	3:27002	SLAC-PUB—1984
	3:27098	SLAC-PUB—1624
	3:27099	SLAC-PUB—1728
	3:27100	SLAC-PUB—1737
	3:27101	SLAC-PUB—1745
	3:27107	SLAC-PUB—1733
	3:27110	SLAC-PUB—1991
	3:27111	SLAC-PUB—1996
	3:27112	SLAC-PUB—2055
	3:27137	SLAC-PUB—1998
	3:27169	SLAC-PUB—1613
	3:27170	SLAC-PUB—1643
	3:27205	SLAC-PUB—2009
	3:27206	SLAC-PUB—2020
	3:27217	SLAC-PUB—1980
	3:27240	SLAC-PUB—1974
	3:27255	SLAC-PUB—1699
EY-76-S-03-0376	**Stanford Linear Accelerator Center, Calif. (USA)**	
	3:26811	SLAC-PUB—1884
	3:26831	SLAC-PUB—1844
	3:26842	SLAC-PUB—1840
	3:27108	SLAC-PUB—1822
	3:27109	SLAC-PUB—1923
	3:27119	SLAC-PUB—1806
	3:27171	SLAC-PUB—1814
	3:27184	SLAC-PUB—1891
EY-76-S-03-0767-004	**California Inst. of Tech., Pasadena (USA)**	
	3:27064	CALT—767P4-161
EY-76-S-05-3630	**Texas Univ., Austin (USA)**	
	3:26948	ORO—3630-26
EY-76-S-05-4043	**Virginia Univ., Charlottesville (USA)**	
	3:27097	ORO—4043-37
EY-76-S-05-4394	**Norfolk State Coll., Va. (USA)**	
	3:26880	ORO—4394-4
EY-76-S-06-2225-019	**Washington Univ., Seattle (USA)**	
	3:26949	RLO/2225/T19—43
EY-76-S-06-2229-005	**Alaska Univ., Fairbanks (USA). Geophysical Inst.**	
	3:27045	RLO/2229/T5—7

Contract No.	Abstract No.	Report No.
EY-76-S-06-2230-004	**Stanford Linear Accelerator Center, Calif. (USA)**	
	3:26740	RLO/2230/T4—191
	3:26741	RLO/2230/T5—192
EY-76-S-06-2230-005	**Oregon Univ., Eugene (USA). Solar Energy Center**	
	3:25982	RLO/2230/T5—1
EY-76-S-06-2434	**Linfield Coll., McMinnville, Oreg. (USA). Research Inst.**	
	3:26490	RLO/2434—1
EY-76-S-09-0735	**Georgia Univ., Athens (USA). Dept. of Zoology**	
	3:26968	SRO—735-5
EY-76-S-09-0888	**Georgia Univ., Athens (USA)**	
	3:26023	SRO—0888-2
EY-77-S-02-4502	**Pittsburgh Univ., Pa. (USA). Dept. of Civil Engineering**	
	3:26947	COO/4502—1
NAS-7-100-954331	**Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Research and Development Center**	
	3:25990	ERDA/JPL/954331—77/3
NAS-7-100-954877	**Eagle-Picher Industries, Inc., Miami, Okla. (USA). Miami Research Labs.**	
	3:25988	DOE/JPL/954877—1
W-31-109-ENG-38	**Argonne National Lab., Ill. (USA)**	
	3:25621	ANL/MSD/FE—77-6R
	3:25719	ANL/AA—12
	3:25720	ANL/AA—13
	3:26059	ANL-K—3805-1
	3:26277	ANL—77-20
	3:26278	ANL-CT—78-9
	3:26421	ANL/SAREF—75-1
	3:26431	ANL—77-44
	3:26432	ANL—77-54
	3:26484	ANL-K—77-3639-1
	3:26485	CONF-7606127—1
	3:26542	ANL—77-79
	3:26802	ANL-HEP-CP—77-60
	3:27215	ANL-HEP-CP—77-81
	3:27312	ANL—77-60
W-7405-ENG-18	**Wisconsin Univ., Madison (USA). Dept. of Metallurgical and Mineral Engineering**	
	3:27014	UCRL—13795
W-7405-ENG-26	**Massachusetts Inst. of Tech., Oak Ridge, Tenn. (USA). School of Chemical Engineering Practice**	
	3:25662	ORNL/MIT—257
	3:25938	ORNL/EIS—115
	3:25939	Y/OWI/SUB—77/42503
	3:25940	Y/OWI/SUB—7009/4
	3:26032	CONF-780216—2
	3:26190	ORNL/TM—6230
	3:26211	ORNL/TM—6130
	3:26227	CONF-771109—90
	3:26255	ORNL/NUREG/TM—164
	3:26283	ORNL/CSD/TM—35
	3:26331	RDT-INDEX—(1-78)
	3:26422	ORNL/TM—5999
	3:26423	ORNL/TM—6200
	3:26439	ORNL/NUREG/TM—142
	3:26440	ORNL/NUREG/TM—143
	3:26441	ORNL/NUREG/TM—182
	3:26594	K/CSD/INF—77/17
	3:26595	Y—2101
	3:26629	ORNL/TM—5895
	3:26817	IAEA-SM—222/57
	3:26821	Y/DD—215
	3:26843	Y/DA—7468
	3:26875	CONF-7710114—1
	3:26932	ORNL/TM—6098
	3:26944	CONF-780108—1
	3:26991	IAEA-SM—222/51
	3:26994	ORNL/EMIC—9
	3:26995	CONF-771147—2
	3:26996	TID—28142
	3:27003	ORNL/NSF/EATC—29
	3:27044	LA-UR—77-2835
	3:27435	ORNL/TM—6111
	3:27592	CONF-771029—203
	3:27617	ORNL/TM—5960
	3:27621	WFPS-TME—055
	3:27636	ORNL/TM—6032
	3:27637	ORNL/TM—6150
	3:27641	WFPS-TME—045
	3:27642	WFPS-TME—056
	3:27643	WFPS-TME—063

Contract No.	Abstract No.	Report No.
W-7405-ENG-36	**Los Alamos Scientific Lab., N.Mex. (USA)**	
	3:25859	LA—7094-PR
	3:25903	LA-UR—77-2863
	3:25907	LA—7128-MS
	3:25959	LA-UR—77-2985
	3:25985	LA—7064-MS
	3:26050	LA-UR—77-186
	3:26051	LA-UR—78-131
	3:26504	LA—6807-PR
	3:26692	LA-UR—77-2790
	3:26737	LA-UR—77-328
	3:26818	LA—7009-MS
	3:26819	LA—7022-MS
	3:26824	LA-UR—77-3001
	3:26888	LA-UR—77-2968
	3:26917	LA—6975-M
	3:26961	LA—7076-PR
	3:26962	LA—7120-MS
	3:26997	LA—7058-PR
	3:27015	LA—6987-MS
	3:27016	LA-UR—77-2818
	3:27024	LA—7092-MS
	3:27506	LA—6824
	3:27616	LA-UR—77-2511
	3:27645	LA-tr—78-10
	3:27648	GA-A—14614(Vol.11)
	3:27705	LA-UR—77-2876
	3:27717	LA-UR—77-2739
W-7405-ENG-48	**California Univ., Livermore (USA). Lawrence Livermore Lab.**	
	3:25644	UCRL—80145
	3:25937	LBL—7004
	3:26004	CONF-780109—3
	3:26021	LBL—5275
	3:26022	LBL—6351
	3:26114	LBL—5931
	3:26212	UCID—17695
	3:26444	UCRL—52314
	3:26495	UCRL—50029-77
	3:26516	TID—28130
	3:26581	UCRL—13805
	3:26588	UCRL—79534
	3:26647	UCRL—76010
	3:26683	UCRL—13808
	3:26770	UCID—17715
	3:26827	UCRL—80183
	3:26830	LBL—7215
	3:26846	UCRL—52353
	3:26856	UCRL—52362
	3:26878	LBL—6372
	3:26879	LBL—7211
	3:26884	UCID—17701
	3:26943	UCRL—13813
	3:26998	UCID—17673
	3:27006	UCRL—52348
	3:27017	UCRL—52295(Pt.2)
	3:27093	UCRL—79860
	3:27147	LBL—6597
	3:27332	LBL—670
	3:27531	UCRL—52363
	3:27658	LBL—6830
	3:27659	UCID—17672
	3:27660	UCID—17692
	3:27671	UCID—17703
	3:27672	UCRL—13677-3
	3:27673	UCRL—52000-77-8
	3:27680	UCRL—79364
	3:27681	UCRL—79653(Rev.1)
	3:27682	UCRL—80162
	3:27709	UCID—17719
	3:27710	UCID—17722
	3:27711	UCRL—80078
W-7405-ENG-82	**Ames Lab., Iowa (USA)**	
	3:26671	IS-M—125
	3:26837	IS-T—792
	3:26952	CONF-770504—
	3:27363	IS-T—795
	3:27367	IS-T—793
W-7405-ENG-92-088	**Battelle Columbus Labs., Ohio (USA)**	
	3:26700	BMI—1982
W7405-ENG-48	**California Univ., Berkeley (USA). Lawrence Berkeley Lab.**	
	3:26803	LBL—7156

V 3 / 11 1 J E 15 7 8 UMI

REPORT NUMBER INDEX

The numbers assigned to all reports cited in the publication appear in the first column of the index. The citation numbers (volume:citation number) are included in the second column. Cross reference information and/or availability are included as appropriate. Abbreviations used in the availability column are elaborated at the end of the index.

Report No.	*Abstract No.*	*Availability*
AD-		
239162	3:26699	NTIS PCA02/MF A01
239477	3:27095	NTIS PCA02/MF A01
AD-A-		
042144	3:26636	NTIS PCA11/MF A01
042178	3:26042	NTIS PCA03/MF A01
042182	3:26488	NTIS PCA02/MF A01
042183	3:27032	NTIS PCA03/MF A01
042185	3:27033	NTIS PCA03/MF A01
042211	3:27397	NTIS PCA02/MF A01
042219	3:26430	NTIS PCA04/MF A01
042226	3:26658	NTIS PCA02/MF A01
042228	3:27056	NTIS PCA02/MF A01
042229	3:26714	NTIS PCA02/MF A01
042233	3:26715	NTIS PCA09/MF A01
042234	3:26482	NTIS PCA03/MF A01
042261	3:27034	NTIS PCA12/MF A01
042271	3:26716	NTIS PCA03/MF A01
042273	3:26669	NTIS PCA02/MF A01
042275	3:26860	NTIS PCA03/MF A01
042276	3:27403	NTIS PCA06/MF A01
042282	3:26717	NTIS PCA03/MF A01
042289	3:26718	NTIS PCA04/MF A01
042298	3:27356	NTIS PCA05/MF A01
042341	3:26719	NTIS PCA05/MF A01
042344	3:26720	NTIS PCA02/MF A01
042346	3:26721	NTIS PCA05/MF A01
042365	3:26929	NTIS PCA14/MF A01
042375	3:25798	NTIS PCA02/MF A01
042385	3:25620	Bechtel Corp., San Francisco
042429	3:26659	NTIS PCA02/MF A01
042456	3:26511	NTIS PCA05/MF A01
042458	3:26722	NTIS PCA02/MF A01
042484	3:26723	NTIS PCA03/MF A01
042490	3:26724	NTIS PCA03/MF A01
042491	3:27035	NTIS PCA03/MF A01
042501	3:27036	NTIS PCA03/MF A01
042525	3:26693	NTIS PCA02/MF A01
042541	3:26487	NTIS PCA02/MF A01
042546	3:26855	NTIS PCA03/MF A01
042547	3:26849	NTIS PCA05/MF A01
042556	3:26481	NTIS PCA05/MF A01
042561	3:26725	NTIS PCA06/MF A01
042571	3:26861	NTIS PCA06/MF A01
042578	3:25973	NTIS PCA05/MF A01
042579	3:26660	NTIS PCA03/MF A01
042584	3:25986	NTIS PCA03/MF A01
042618	3:26690	NTIS PCA02/MF A01
042632	3:26862	NTIS PCA02/MF A01
042641	3:26553	NTIS PCA02/MF A01
042667	3:27398	NTIS PCA04/MF A01
042671	3:26726	NTIS PCA02/MF A01
042674	3:26727	NTIS PCA02/MF A01
042687	3:27037	NTIS PCA03/MF A01
043284	3:27536	NTIS PCA02/MF A01
043319	3:26728	
043323	3:26590	NTIS PCA04/MF A01
043330	3:25968	NTIS PCA02/MF A01
043336	3:27025	NTIS PCA02/MF A01
043339	3:26729	NTIS PCA02/MF A01
043340	3:26645	NTIS PCA02/MF A01
043372	3:27026	NTIS PCA02/MF A01
043382	3:25987	NTIS PCA07/MF A01
043386	3:26863	NTIS PCA04/MF A01
043387	3:26850	NTIS PCA07/MF A01
043389	3:26864	NTIS PCA04/MF A01
043390	3:26865	NTIS PCA05/MF A01
043398	3:26851	NTIS PCA10/MF A01
043457	3:26999	NTIS PCA10/MF A01
043458	3:27000	NTIS PCA03/MF A01
043486	3:27481	NTIS PCA08/MF A01
043499	3:26852	NTIS PCA07/MF A01
043502	3:27399	NTIS PCA03/MF A01
043519	3:26833	
043524	3:26853	
043546	3:27039	
043547	3:27040	
043566	3:25812	NTIS PCA03/MF A01
043571	3:27482	NTIS PCA05/MF A01
043666	3:27038	NTIS PCA05/MF A01
043684	3:26854	NTIS PCA05/MF A01
043701	3:26338	Availability: Microfiche copies only.
043706	3:27001	NTIS PCA03/MF A01
043713	3:26905	
043776	3:26834	NTIS PCA02/MF A01
043777	3:26835	NTIS PCA05/MF A01
043807	3:27400	NTIS PCA03/MF A01
043808	3:26730	NTIS PCA06/MF A01
043812	3:26731	NTIS PCA04/MF A01
043843	3:25796	NTIS PCA05/MF A01
043873	3:27041	
043876	3:25979	NTIS PCA05/MF A01
046004	3:26732	NTIS PCA02/MF A01
046008	3:26554	NTIS PCA03/MF A01
046014	3:26733	NTIS PCA02/MF A01
046052	3:26869	NTIS PCA05/MF A01
046061	3:26712	NTIS PCA07/MF A01
046092	3:27042	NTIS PCA04/MF A01
046114	3:26844	NTIS PCA04/MF A01
046120	3:26540	NTIS PCA03/MF A01
046123	3:25799	NTIS PCA04/MF A01
046146	3:26858	NTIS PCA04/MF A01
046169	3:26836	NTIS PCA10/MF A01
046201	3:26886	NTIS PCA02/MF A01
046203	3:26933	NTIS PCA04/MF A01
046237	3:27043	NTIS PCA03/MF A01
046256	3:25800	NTIS PCA05/MF A01
AD-B-		
009019	3:26734	NTIS PCA05/MF A01
015785	3:26735	NTIS PCA05/MF A01
ADL-		
74685-3	3:26929	*See* AD-A-042365
AED-Conf-		
77-165-002	3:26870	Dep. NTIS (US Sales Only), PC A02/MF A01
77-195-006	3:26151	Dep. NTIS (US Sales Only), PC A02/MF A01

Report No.	Abstract No.	Availability
AERL-RR-		
432	3:26726	*See* AD-A-042671
AFAL-TR-		
77-158	3:27041	*See* AD-A-043873
AFAPL-TR-		
75-92(Pt.2)	3:26482	*See* AD-A-042234
76-111	3:26540	*See* AD-A-046120
AFGL-ERP-		
586	3:27035	*See* AD-A-042491
AFGL-TR-		
76-0308	3:27035	*See* AD-A-042491
AFLRL-		
81	3:26590	*See* AD-A-043323
88	3:25812	*See* AD-A-043566
AI-DOE-		
13208	3:26274	AT
13211	3:26275	AT
13216	3:26276	Dep. NTIS, PC A04/MF A01
ANL-		
77-20	3:26277	Dep. NTIS, PC A04/MF A01
77-44	3:26431	Dep. NTIS, PC A07/MF A01
77-54	3:26432	Dep. NTIS, PC A04/MF A01
77-60	3:27312	Dep. NTIS, PC A10/MF A01
77-79	3:26542	Dep. NTIS, PC A03/MF A01
ANL/AA-		
12	3:25719	Dep. NTIS, PC A04/MF A01
13	3:25720	Dep. NTIS, PC A04/MF A01
ANL-CT-		
78-9	3:26278	AT
ANL-HEP-CP-		
77-60	3:26802	Dep. NTIS, PC A02/MF A01
77-81	3:27215	Dep. NTIS, PC A02/MF A01
ANL-K-		
77-3639-1	3:26484	Dep. NTIS, PC A04/MF A01
3805-1	3:26059	Dep. NTIS, PC A04/MF A01
ANL/MSD/FE-		
77-6R	3:25621	Dep. NTIS, PC A02/MF A01
ANL/SAREF-		
75-1	3:26421	Dep. NTIS, PC A08/MF A01
ANL-Trans-		
1111	3:26289	Dep. NTIS, PC A02/MF A01
1112	3:26288	Dep. NTIS, PC A02/MF A01
1113	3:26287	Dep. NTIS, PC A02/MF A01
1114	3:26286	Dep. NTIS, PC A02/MF A01
1121	3:26285	Dep. NTIS, PC A02/MF A01
AVSD-		
0022-77-RR(Vol.7)	3:26587	*See* PB-270995
B-		
181963	3:25915	*See* ID-75-45
BBN-		
3531	3:26862	*See* AD-A-042632
BC-SDAL-		
77-02	3:27034	*See* AD-A-042261
BCR-L-		
841	3:25707	*See* COO/4427-1
BDX-		
613-1668(Rev.)	3:26845	Dep. NTIS, PC A02/MF A01
613-1907	3:26736	Dep. NTIS, PC A02/MF A01
BERC-		
77/4	3:25745	Dep. NTIS, PC A07/MF A01
BERC/RI-		
77/15	3:25746	Dep. NTIS, PC A03/MF A01
78/3	3:26577	Dep. NTIS, PC A02/MF A01
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77/8	3:26591	Dep. NTIS, PC A02/MF A01
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7511	3:25694	*See* PB-270696
BM-CT-		
4-11	3:25882	*See* PB-269450
BM-IC-		
8737	3:25686	*See* PB-269945
8740	3:25695	*See* PB-272699
BM-MYB-		
1974(Vol.3)	3:27013	*See* PB-269706
BM-RI-		
8260	3:25689	Bureau of Mines, Washington, DC
8266	3:25690	Bureau of Mines, Washington, DC
8267	3:25691	Dep. NTIS, PC A02/MF A01
8269	3:25706	Dep. NTIS, PC A02/MF A01
BMFT-FB-T-		
77-01	3:26555	Dep. NTIS (US Sales Only), PC A12/MF A01
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23394	3:27057	Dep. NTIS, PC A02/MF A01
23461	3:27338	Dep. NTIS, PC A03/MF A01
23513	3:27106	Dep. NTIS, MF A01
23532	3:26804	Dep. NTIS, MF A01
23533	3:26805	Dep. NTIS, MF A01
23534	3:26806	Dep. NTIS, MF A01
23535	3:26807	Dep. NTIS, MF A01
23536	3:26808	Dep. NTIS, PC A02/MF A01
23538	3:26809	Dep. NTIS, MF A01
23539	3:26810	Dep. NTIS, PC A02/MF A01
23550	3:26670	Dep. NTIS, PC A02/MF A01
23558	3:26967	Dep. NTIS, MF A01
23579	3:26871	Dep. NTIS, PC A02/MF A01
23612	3:27136	Dep. NTIS, PC A02/MF A01
23652	3:26799	Dep. NTIS, PC A02/MF A01
23653	3:26800	Dep. NTIS, MF A01
23654	3:26801	Dep. NTIS, PC A02/MF A01
23655	3:26795	Dep. NTIS, PC A04/MF A01
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23765	3:25710	Dep. NTIS, MF A01
50644	3:26777	Dep. NTIS, PC A02/MF A01
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50717	3:27313	Dep. NTIS, PC A03/MF A01
BNWL-		
1997	3:25935	Dep. NTIS, PC A09/MF A01
2207	3:26989	Dep. NTIS, PC A03/MF A01
2219	3:26873	Dep. NTIS, PC A08/MF A01
2395	3:26939	Dep. NTIS, PC A02/MF A01
BNWL-RAP-		
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BRL-MR-		
2761	3:27398	*See* AD-A-042667
CALSPAN-NA-		
6019-M-2	3:26920	*See* PB-273463
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3859	3:27500	Dep. NTIS (US Sales Only), PC A02/MF A01
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3863	3:27426	Dep. NTIS (US Sales Only), PC A02/MF A01
3864	3:27652	Dep. NTIS (US Sales Only), PC A02/MF A01
3865	3:27653	Dep. NTIS (US Sales Only), PC A02/MF A01
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252-NP	3:26433	Combustion Engineering, Inc., Windsor, CT
CERL-IR-E-		
110	3:25973	*See* AD-A-042578
111	3:26660	*See* AD-A-042579
112	3:26659	*See* AD-A-042429
CERL-TR-E-		
114	3:26042	*See* AD-A-042178
CLM-R-		
164	3:27501	Dep. NTIS (US Sales Only), PC A03/MF A01
165	3:27631	Dep. NTIS (US Sales Only), PC A03/MF A01
CONF-740395-		(Symposium on mathematical physics and physical mathematics, Warsaw, Poland, 25-30 Mar 1975)
	3:27419	Boston; D. Reidel Publishing Co. (1976). $39.00
CONF-750654-		(High energy particle physics divisional conference of EPS, Palermo, Italy, 23-28 Jun 1975)
60	3:27169	*See* SLAC-PUB-1613
61	3:27098	*See* SLAC-PUB-1624
CONF-7506176-		(Proceedings of weak and electromagnetic interactions at high energies, Cargese, France, 30 Jun-25 Jul 1975)
P1	3:27292	New York; Plenum Press (1976). $39.50
CONF-750754-		(Summer Institute on Particle Physics, Stanford, CA, USA, 21-31 Jul 1975)
4	3:27107	*See* SLAC-PUB-1733
CONF-751025-		(Course on high energy radiation dosimetry and protection, Erice, Italy, 1-10 Oct 1975)
2	3:26796	*See* SLAC-PUB-1805

V 3 / 11 1 J E 15 78 UMI

Report No.	Abstract No.	Availability
CONF-7511141-		(Meson physics facility users group, Los Alamos, NM, USA, 10-11 Nov 1975)
1	3:27255	*See* SLAC-PUB-1699
CONF-760210-		(Nevada applied ecology group plutonium and other transuranics information conference, Las Vegas, NV, USA, 12-13 Feb 1976)
	3:26909	*See* NVO-171
CONF-760262-		(International meeting on storage ring physics, Flaine, France, 22-28 Feb 1976)
1	3:27101	*See* SLAC-PUB-1745
CONF-760344-		(Conference on particle searches and discoveries, Nashville, TN, USA, 1-3 Mar 1976)
4	3:27099	*See* SLAC-PUB-1728
CONF-7603114-		(Royal Society on - New Particles and New Quantum Numbers, London, UK, 11 Mar 1976)
1	3:27100	*See* SLAC-PUB-1737
CONF-760631-		(9. symposium on fusion technology, Garmisch-Partenkirchen, F.R. Germany, 14-18 Jun 1976)
	3:27539	*See* EUR-5602
CONF-760652-		(Health Physics Society meeting, San Francisco, CA, USA, 27 Jun-2 Jul 1976)
7	3:26820	*See* SLAC-PUB-1768
CONF-760672-		(7. international colloquium on multiparticle reactions, Tutzing, F.R. Germany, 21-25 Jun 1976)
4	3:27171	*See* SLAC-PUB-1814
5	3:27119	*See* SLAC-PUB-1806
CONF-7606127-		(27. power sources conference, Ft. Monmouth, NJ, USA, 21 Jun 1976)
1	3:26485	Dep. NTIS, PC A02/MF A01
CONF-7606132-		(Symposium on quark binding, Rochester, NY, USA, 14-18 Jun 1976)
	3:27160	New York; John Wiley and Sons (1977). $24.95
CONF-760719-		(18. international conference on high energy physics, Tbilisi, USSR, 15-21 Jul 1976)
37	3:27108	*See* SLAC-PUB-1822
38	3:27119	*See* SLAC-PUB-1806
39	3:27171	*See* SLAC-PUB-1814
CONF-760729-		(Topical conference on Baryon Resonances, Oxford, UK, 5-9 Jul 1976)
8	3:27216	*See* SLAC-PUB-1774
CONF-760832-		(20. annual SPIE technical symposium, San Diego, CA, USA, 24-25 Aug 1976)
P1	3:25983	Palos Verdes Estates, CA; Society of Photo-Optical Instrumentation Engineers (1977). $34.00
CONF-760860-		(13. international conference on physics of semiconductors, Rome, Italy, 30 Aug-3 Sep 1976)
	3:26767	New York; Elsevier/North-Holland Inc. (1976).
CONF-7608115-		(International congress on engineering and food, Boston, MA, USA, 9-13 Aug 1976)
1	3:26021	*See* LBL-5275
CONF-7609156-		(Seminar on the impact of alternate fuels on refractories and refractory insulations, Washington, DC, USA, 21 Sep 1976)
	3:26629	*See* ORNL/TM-5895
CONF-761006-		(Nuclear science, scintillation and semiconductor counter symposium, New Orleans, LA, USA, 20-22 Oct 1976)
50	3:26842	*See* SLAC-PUB-1840
51	3:26831	*See* SLAC-PUB-1844
CONF-7610120-		(Conference on the operation of instruments in adverse environments, London, UK, 4-5 Oct 1976)
	3:26816	American Inst. of Physics, New York
CONF-761108-		(Plasma physics meeting of the American Physical Society, San Francisco, CA, USA, 15-19 Nov 1976)
35	3:27667	*See* CEA-CONF-3886
CONF-761232-		(National congress on plasma physics, Paris, France, 6 Dec 1976)
4	3:27500	*See* CEA-CONF-3859
5	3:27611	*See* EUR-CEA-FC-889
6	3:27608	*See* CEA-CONF-3860
7	3:27426	*See* CEA-CONF-3863
8	3:27652	*See* CEA-CONF-3864
9	3:27653	*See* CEA-CONF-3865
CONF-770124-		(Conference of the Orbis Scientiae Center for Theoretical Studies, Coral Gables, FL, USA, 16-21 Jan 1977)
8	3:27184	*See* SLAC-PUB-1891
CONF-770149-		(Conference of the Netherlands National Energy Research Steering Group, Utrecht, Netherlands, 27 Jan 1977)
	3:26514	Dep. NTIS (US Sales Only), PC A06/MF A01
CONF-770151-		(Meeting of the cooling tower institute, Houston, TX, USA, 31 Jan-2 Feb 1977)
9	3:26129	Midwest Research Inst., Kansas City, MO
CONF-770246-		(Sonnenenergie: Anwendungen, Systeme, Erfahrungen, Essen, F.R. Germany, 4 Feb 1977)
	3:26043	NTIS (US Sales Only), PC A05/MF A01
CONF-770256-		(2. winter colloquium on laser induced chemistry, Park City, UT, USA, 13-16 Feb 1977)
1	3:26737	*See* LA-UR-77-328
CONF-770313-		(Particle accelerator conference, Chicago, IL, USA, 16-18 Mar 1977)
117	3:26812	*See* SLAC-PUB-1898
135	3:26811	*See* SLAC-PUB-1884
CONF-770319-		(12. Rencontre de Moriond, Haute-Savoie, France, 6-18 Mar 1977)
6	3:27109	*See* SLAC-PUB-1923
CONF-770346-		(Symposium on excited states in organic and biochemistry, Jerusalem, Israel, 28-31 Mar 1977)
3	3:26946	*See* COO-3277-44
CONF-770406-		(5. international conference on experimental meson spectroscopy, Boston, MA, USA, 29-30 Apr 1977)
5	3:27110	*See* SLAC-PUB-1991
6	3:27240	*See* SLAC-PUB-1974
7	3:27217	*See* SLAC-PUB-1980
CONF-770504-		(14. annual proceedings on electron microscopy, Ames, IA, USA, 12-13 May 1977)
	3:26952	Dep. NTIS, PC A09/MF A01
CONF-7705108-		(American Industrial Hygiene Association meeting aerosol technological symposium, New Orleans, LA, USA, 22-27 May 1977)
1	3:26872	*See* BNL-23672
CONF-770696-		(International conference on neutrino physics and neutrino astrophysics, Elbrus, USSR, 18-24 Jun 1977)
5	3:27111	*See* SLAC-PUB-1996
CONF-770697-		(8. international symposium on multi-particle dynamics, Kaysersberg, France, 12-19 Jun 1977)
2	3:27226	*See* COO-3069-556
3	3:27205	*See* SLAC-PUB-2009
CONF-7706118-		(Conference on engineering problems of thermonuclear reactors, Leningrad, USSR, 28-30 Jun 1977)
1	3:27650	*See* LA-tr-78-13
CONF-770709-		(10. international conference on high energy accelerators, Serpukhov, USSR, 11-17 Jul 1977)
20	3:26813	*See* SLAC-PUB-1971
21	3:26797	*See* SLAC-PUB-1948
CONF-770729-		(Symposium on instrumentation and control for fossil demonstration plants, Chicago, IL, USA, 13-15 Jul 1977)
13	3:26434	*See* GA-A-14592
CONF-770736-		(INS international symposium on new particles and the structure of hadrons, Tokyo, Japan, 12-14 Jul 1977)
2	3:27137	*See* SLAC-PUB-1998
CONF-770753-		(Isabelle workshop, Upton, NY, USA, 18-29 Jul 1977)
4	3:26807	*See* BNL-23535
5	3:26804	*See* BNL-23532
6	3:26806	*See* BNL-23534
8	3:26810	*See* BNL-23539
17	3:26809	*See* BNL-23538
18	3:26805	*See* BNL-23533
28	3:26808	*See* BNL-23536
CONF-770814-		(American Chemical Society meeting, Chicago, IL, USA, 29 Aug-2 Sep 1977)
12	3:25622	Inst. of Gas Technology, Chicago

Report No.	Abstract No.	Availability
CONF-770842-		(6. international conference on magnet technology, Bratislava, Czechoslovakia, 29 Aug-2 Sep 1977)
18	3:27002	*See* SLAC-PUB-1984
19	3:26814	*See* SLAC-PUB-2045
CONF-770861-		(Conference on changing career opportunities in physics, University Park, PA, USA, 1-3 Aug 1977)
	3:27425	New York; American Institute of Physics (1978).
CONF-770873-		(7. international conference on high energy physics and nuclear structure, Zurich, Switzerland, 30 Aug 1977)
3	3:27332	*See* LBL-670
CONF-770874-		(Proceedings of the statistical computing section-American Statistical Association, Chicago, IL, USA, 15-18 Aug 1977)
3	3:26871	*See* BNL-23579
CONF-770879-		(5. international conference on liquefied natural gas, Dusseldorf, F.R. Germany, 29 Aug-1 Sep 1977)
P1	3:25845	Chicago; Institute of Gas Technology (1977). $43.00 for Volumes I and II
P2	3:25857	Chicago; Institute of Gas Technology (1977). $43.00 for Volumes I and II
CONF-770883-		(Symposium on lepton and photon interactions at high energies, Hamburg, F.R. Germany, 25-31 Aug 1977)
2	3:27106	*See* BNL-23513
CONF-770885-		(2. symposium on stationary source combustion, New Orleans, LA, USA, 29 Aug-1 Sep 1977)
1	3:26778	Inst. of Gas Technology, Chicago
CONF-770906-		(8. European conference on controlled fusion and plasma physics, Prague, Czechoslovakia, 19-23 Sep 1977)
10	3:27491	*See* IPP-III/35
CONF-770940-		(Symposium on the production and neutralization of negative hydrogen ions and beams, Upton, NY, USA, 26-30 Sep 1977)
18	3:26799	*See* BNL-23652
21	3:26800	*See* BNL-23653
22	3:26795	*See* BNL-23655
23	3:26801	*See* BNL-23654
CONF-770953-		(Concentrating solar collector conference, Atlanta, GA, USA, 26-28 Sep 1977)
4	3:26062	*See* SAND-77-1466C
9	3:26061	*See* ERDA/NASA/1060-77/1
CONF-770965-		(Symposium and workshop on moving boundary problems, Gatlinburg, TN, USA, 26-28 Sep 1977)
1	3:26594	*See* K/CSD/INF-77/17
CONF-770968-		(International conference on nuclear structure, Tokyo, Japan, 5-10 Sep 1977)
11	3:27332	*See* LBL-670
CONF-770972-		(Symposium program RMAG fall field conference, Snowmass, CO, USA, 29 Sep 1977)
	3:25729	Denver; Rocky Mountain Association of Geologists (1977). $25.00
CONF-770995-		(Symposium on future accelerators, Bombay, India, 19 Sep 1977)
1	3:27147	*See* LBL-6597
CONF-771008-		(International meeting on advanced LMFBR fuels, Tucson, AZ, USA, 10-13 Oct 1977)
	3:26292	La Grange Park, IL; American Nuclear Society (1977).
CONF-771023-		(Nuclear science symposium, San Francisco, CA, USA, 19-21 Oct 1977)
33	3:26830	*See* LBL-7215
CONF-771029-		(7. symposium on fusion research project, Knoxville, TN, USA, 25-29 Oct 1977)
201	3:27643	*See* WFPS-TME-063
203	3:27592	Dep. NTIS, PC A02/MF A01
205	3:27640	*See* UWFDM-225
207	3:27621	*See* WFPS-TME-055
208	3:27642	*See* WFPS-TME-056
CONF-771031-		(21. conference on analytical chemistry in energy technology, Gatlinburg, TN, USA, 4-6 Oct 1977)
11	3:26661	*See* HEDL-SA-1258
CONF-771037-		(ERDA contractors' coordination meeting, Detroit, MI, USA, 4 Oct 1977)
2	3:26578	*See* CONS/1011-22
CONF-771039-		(13. rare earth research conference, Olgebay Park, WV, USA, 16-20 Oct 1977)
9	3:27680	*See* UCRL-79364
10	3:25963	Inst. of Gas Technology, Chicago
CONF-771040-		(Electro-Optical systems conference, Anaheim, CA, USA, 25-27 Oct 1977)
9	3:26736	*See* BDX-613-1907
10	3:26692	*See* LA-UR-77-2790
CONF-771059-		(Symposium on heavy-ion elastic scattering, Rochester, NY, USA, 25-26 Oct 1977)
7	3:27338	*See* BNL-23461
CONF-771070-		(Conference on water chlorination: environmental impact and health effects, Gatlinburg, TN, USA, 31 Oct-4 Nov 1977)
4	3:26878	*See* LBL-6372
CONF-771074-		(Association of System 2000 Users for technical exchange fall conference, San Francisco, CA, USA, 19-21 Oct 1977)
2	3:27717	*See* LA-UR-77-2739
CONF-771078-		(Workshop on ISOL systems, Upton, NY, USA, 31 Oct-1 Nov 1977)
2	3:26803	*See* LBL-7156
CONF-771089-		(Particles and fields meeting, Argonne, IL, USA, 6-8 Oct 1977)
4	3:27136	*See* BNL-23612
CONF-771092-		(9. synthetic pipeline gas symposium, Chicago, IL, USA, 31 Oct-2 Nov 1977)
9	3:25623	Inst. of Gas Technology, Chicago
CONF-7710107-		(Conference on parity nonconservation, weak neutral currents and gauge theories, Batavia, IL, USA, 20-22 Oct 1977)
1	3:27112	*See* SLAC-PUB-2055
CONF-7710108-		(Symposium on application of reliability techniques to nuclear power plants, Vienna, Austria, 10-14 Oct 1977)
2	3:26357	*See* GEFR-SP-050
CONF-7710114-		(5. life sciences symposium, Los Alamos, NM, USA, Oct 1977)
1	3:26875	Dep. NTIS, PC A03/MF A01
CONF-7710116-		(Low-btu gas: its future, Dundee, IL, USA, 2-4 Oct 1977)
1	3:25625	Institute of Gas Technology, Chicago, IL
CONF-771102-		(20. annual AICHE meeting, New York, NY, USA, 13-17 Nov 1977)
15	3:27681	*See* UCRL-79653(Rev.1)
CONF-771109-		(ANS winter meeting, San Francisco, CA, USA, 27 Nov-2 Dec 1977)
90	3:26227	Dep. NTIS, MF A01
93	3:26887	*See* DP-MS-77-41
CONF-771110-		(24. national vacuum symposium of the American Vacuum Society, Boston, MA, USA, 8-11 Nov 1977)
9	3:26815	*See* SLAC-PUB-2053
CONF-771112-		(29. annual southeastern regional meeting of the American Chemical Society, Tampa, FL, USA, 9-11 Nov 1977)
3	3:26114	*See* LBL-5931
CONF-771113-		(4. joint conference on sensing of environmental pollutants, New Orleans, LA, USA, 6-11 Nov 1977)
12	3:26879	*See* LBL-7211
CONF-771129-		(Workshop on fusion fueling, Princeton, NJ, USA, 1-3 Nov 1977)
9	3:27658	*See* LBL-6830
CONF-771131-		(DOE annual chemical energy storage and hydrogen energy system contracts review, Baltimore, MD, USA, 16-17 Nov 1977)
3	3:25959	*See* LA-UR-77-2985
CONF-771136-		(Annual American Physical Society meeting, Atlanta, GA, USA, 7-11 Nov 1977)
7	3:27093	*See* UCRL-79860
25	3:27537	Dep. NTIS, PC A02/MF A01
CONF-771147-		(Symposium on the Syrian hamster in toxicology, Cambridge, MA, USA, 30 Nov-2 Dec 1977)
2	3:26995	Dep. NTIS, MF A01
CONF-771149-		(Combustion Institute Eastern State meeting, Hartford, CT, USA, 10-11 Nov 1977)
1	3:26670	*See* BNL-23550

Report No.	Abstract No.	Availability
CONF-771153-		(3. geopressured geothermal energy conference, Lafayette, LA, USA, 16-18 Nov 1977)
1	3:25826	Institute of Gas Technology, Chicago, IL
CONF-771201-		(IEEE international electron devices meeting, Washington, DC, USA, 5-7 Dec 1977)
4	3:25995	*See* SAND-77-1269C
CONF-771203-		(Alternative energy sources symposium, Miami Beach, FL, USA, 5-7 Dec 1977)
7	3:26483	*See* SAND-77-8665
CONF-771206-		(Digital signal processing symposium, Albuquerque, NM, USA, 6-7 Dec 1977)
3	3:27707	*See* SAND-77-1684C
CONF-771209-		(IAEA symposium on national and international standardization of radiation dosimetry, Atlanta, GA, USA, 5-9 Dec 1977)
2	3:27057	*See* BNL-23394
3	3:26827	*See* UCRL-80183
6	3:26817	*See* IAEA-SM-222/57
8	3:26991	*See* IAEA-SM-222/51
CONF-771210-		(Meeting on fuel and clad motion diagnostics for fast reactor safety test facilities, Los Alamos, NM, USA, 5 Dec 1977)
3	3:26358	*See* SAND-77-0533C
CONF-771219-		(5. international conference on fluidized bed combustion, Washington, DC, USA, 12-14 Dec 1977)
2	3:25710	*See* BNL-23765
CONF-771222-		(IAEA symposium on natural fission reactors, Paris, France, 19-21 Dec 1977)
3	3:25903	*See* LA-UR-77-2863
5	3:27016	*See* LA-UR-77-2818
CONF-771229-		(Solar heating and cooling demonstration program contractors review, New Orleans, LA, USA, 5-7 Dec 1977)
(Summ.)	3:26044	Dep. NTIS, PC A03/MF A01
CONF-780106-		(Ionospheric effects symposium, Washington, DC, USA, 24-26 Jan 1978)
2	3:27044	*See* LA-UR-77-2835
CONF-780108-		(Symposium on the role of compartmentation in metabolic regulation: micro-environmental aspects, Dallas, TX, USA, 16-17 Jan 1978)
1	3:26944	Dep. NTIS, PC A02/MF A01
CONF-780109-		(Technology for energy conservation, Albuquerque, NM, USA, 23-27 Jan 1978)
3	3:26004	Dep. NTIS, PC A03/MF A01
CONF-780110-		(11. symposium on radiation instrumentation, San Diego, CA, USA, 17-19 Jan 1978)
2	3:26824	*See* LA-UR-77-3001
3	3:26888	*See* LA-UR-77-2968
CONF-780114-		(International Solar Energy Congress, New Delhi, India, 16-21 Jan 1978)
2	3:26051	*See* LA-UR-78-131
CONF-780202-		(Topical meeting on inertial confinement fusion, San Diego, CA, USA, 7 Feb 1978)
14	3:27670	*See* SAND-77-1587C
15	3:27682	*See* UCRL-80162
CONF-780208-		(Society of Automotive Engineers International Automotive Engineering Congress and Exposition, Detroit, MI, USA, Feb 1978)
1	3:26588	*See* UCRL-79534
CONF-780216-		(SERI storage applications workshop, Golden, CO, USA, 14-15 Feb 1978)
2	3:26032	Dep. NTIS, PC A03/MF A01
CONF-780220-		(Advances in reentry thermal protection technology, Los Angeles, CA, USA, 15 Feb 1978)
1	3:26632	*See* SAND-782076C
CONF-780305-		(Division of fuel chemistry meeting, Anaheim, CA, USA, 12-17 Mar 1978)
2	3:25664	*See* SAND-77-1560C
5	3:26671	*See* IS-M-125
8	3:25663	*See* SAND-77-1558C
9	3:25644	*See* UCRL-80145
10	3:25624	Inst. of Gas Tech., Chicago, IL
CONF-780306-		(Symposium on late biological effects of ionizing radiation, Vienna, Austria, 13-17 Mar 1978)
1	3:26985	*See* SAND-77-1352C
CONF-780308-		(NACE meeting on corrosion, Houston, TX, USA, 6-10 Mar 1978)
5	3:25936	*See* DP-MS-77-115
CONF-780401-		(Topical meeting on advances in reactor physics, Gatlinburg, TN, USA, 9-12 Apr 1978)
1	3:27616	*See* LA-UR-77-2511
CONF-780403-		(IEEE international conference on acoustics, speech and signal processing, Tulsa, OK, USA, 10-12 Apr 1978)
1	3:27705	*See* LA-UR-77-2876
2	3:27711	*See* UCRL-80078
CONF-780404-		(IEEE region 3 conference and exhibit, Atlanta, GA, USA, 10-12 Apr 1978)
1	3:26843	*See* Y/DA-7468
CONF-780409-		(4. international symposium on jet and cutting technology, Canterbury, UK, 12-14 Apr 1978)
1	3:26704	Institute of Gas Technology, Chicago, IL
CONS/1011-		
22	3:26578	Dep. NTIS, PC A02/MF A01
CONS/5053-		
1	3:26579	Dep. NTIS, PC A02/MF A01
COO-		
1717-9	3:26788	Dep. NTIS, PC A03/MF A01
2223-25	3:26959	Dep. NTIS, PC A02/MF A01
2245-35TR	3:26279	Dep. NTIS, PC A03/MF A01
2245-37TR	3:26280	Dep. NTIS, PC A03/MF A01
2245-40TR	3:26281	Dep. NTIS, PC A04/MF A01
2245-47TR	3:26405	Dep. NTIS, PC A08/MF A01
2456-52	3:27502	Dep. NTIS, PC A04/MF A01
2874-16	3:26876	Dep. NTIS, PC A04/MF A01
2930-12	3:26060	Dep. NTIS, PC A07/MF A01
3069-556	3:27226	Dep. NTIS, MF A01
3110-28	3:26960	Dep. NTIS, PC A02/MF A01
3130TA-340	3:27146	Dep. NTIS, PC A02/MF A01
3158-55	3:27055	Dep. NTIS, PC A02/MF A01
3162-36	3:26945	Dep. NTIS, PC A02/MF A01
3231-5	3:26969	Dep. NTIS, PC A02/MF A01
3264-16	3:26987	Dep. NTIS, PC A02/MF A01
3277-44	3:26946	Dep. NTIS, PC A02/MF A01
3497-24	3:27538	Dep. NTIS, PC A02/MF A01
3566-19	3:26930	Dep. NTIS, MF A01
COO/2641-		
3	3:26040	Dep. NTIS, PC A04/MF A01
COO/2769-		
2	3:26045	Dep. NTIS, PC A05/MF A01
COO/2835-		
1	3:26582	Dep. NTIS, MF A01
COO/2991-		
19	3:26005	Dep. NTIS, PC A07/MF A01
COO/4121-		
2(Vol.1)	3:26202	Dep. NTIS, PC A10/MF A01
COO/4268-		
1	3:26971	Dep. NTIS, PC A05/MF A01
COO/4427-		
1	3:25707	Dep. NTIS, PC A03/MF A01
COO/4502-		
1	3:26947	Dep. NTIS, PC A02/MF A01
COO/4511-		
2	3:26046	Dep. NTIS, MF A01
CRREL-SR-		
77-30	3:26554	*See* AD-A-046008
DIN-		
25434	3:26456	Berlin, Germany, F.R.; Beuth (Oct 1977).
25435(pt.1)	3:26215	Berlin, Germany, F.R.; Beuth (Oct 1977).
DOE/EA-		
0001	3:26489	Dep. NTIS, MF A01
DOE/EV-		
0002	3:25858	Dep. NTIS, PC A20/MF A01
DOE/JPL/1060-		
1	3:26038	Dep. NTIS, PC A05/MF A01
DOE/JPL/954877-		
1	3:25988	Dep. NTIS, PC A02/MF A01
DOE-tr-		
26	3:26575	Dep. NTIS, PC A07/MF A01
DP-MS-		
77-41	3:26887	Dep. NTIS, PC A02/MF A01
77-115	3:25936	Dep. NTIS, PC A02/MF A01
DPST-		
75-426-TL	3:25928	Dep. NTIS, MF A01
DSE/2538-		
1	3:25989	Dep. NTIS, PC A05/MF A01
DSE/4017-		
1	3:26047	Dep. NTIS, PC A03/MF A01

Report No.	Abstract No.	Availability
E-		
77-10184	3:26921	NTIS PCA05/MF A01
ECOM-		
4504	3:26693	*See* AD-A-042525
EMD-		
77-16	3:26515	General Accounting Office, Washington, DC
77-19	3:25806	General Accounting Office, Washington, DC, $1.00
77-57	3:26494	General Accounting Office, Washington, DC
77-59	3:26519	General Accounting Office, Washington, DC
78-10	3:25862	General Accounting Office, Washington, DC, $1.00
EPA-		
450/2-75-003	3:26877	Environmental Protection Agency, Research Triangle Park, NC
600/9-77-013	3:26192	NTIS
600/9-77-019	3:25801	NTIS
600/9-77-033	3:25902	NTIS
EPRI-AF-		
560	3:25677	Dep. NTIS, PC A18/MF A01
579	3:25647	Dep. NTIS, PC A04/MF A01
585	3:25648	Dep. NTIS, PC A12/MF A01
610	3:26189	Dep. NTIS, PC A04/MF A01
EPRI-EA-		
592	3:26497	Dep. NTIS, PC A05/MF A01
593	3:26498	Dep. NTIS, PC A05/MF A01
EPRI-EM-		
576	3:26543	Dep. NTIS, PC A05/MF A01
EPRI-ER-		
589-SR	3:26029	Dep. NTIS, PC A04/MF A01
594	3:26048	Dep. NTIS, PC A12/MF A01
EPRI-FP-		
539	3:25626	Dep. NTIS, PC A06/MF A01
595	3:25678	Dep. NTIS, PC A17/MF A01
628	3:25711	Dep. NTIS, PC A06/MF A01
639	3:25679	Dep. NTIS, PC A04/MF A01
671	3:25680	Dep. NTIS, PC A12/MF A01
EPRI-NP-		
534	3:26356	Dep. NTIS, PC A03/MF A01
604	3:26412	Dep. NTIS, PC A05/MF A01
EPRI-RD-		
3	3:26521	Dep. NTIS, PC A25/MF A01
ERDA/JPL/954331-		
77/3	3:25990	Dep. NTIS, PC A04/MF A01
ERDA/NASA/1028-		
77/12	3:26126	Dep. NTIS, PC A03/MF A01
ERDA/NASA/1060-		
77/1	3:26061	Dep. NTIS, PC A02/MF A01
ERDA/USDA-		
19464/76/FR-3	3:26020	Dep. NTIS, PC A09/MF A01
ERT-P-		
1839	3:26193	*See* PB-273019
EUR-		
5602	3:27539	NTIS
EUR-CEA-FC-		
886	3:27428	Dep. NTIS (US Sales Only), PC A04/MF A01
887	3:27490	Dep. NTIS (US Sales Only), PC A02/MF A01
889	3:27611	Dep. NTIS (US Sales Only), PC A03/MF A01
893	3:27612	Dep. NTIS (US Sales Only), PC A02/MF A01
895	3:27561	Dep. NTIS (US Sales Only), PC A02/MF A01
FAA-NA-		
77-35	3:25796	*See* AD-A-043843
FE-		
1207-40	3:25627	Dep. NTIS, PC A03/MF A01
1514-73	3:25628	Dep. NTIS, PC A02/MF A01
1517-55	3:25649	Dep. NTIS, PC A02/MF A01
1517-58	3:25650	Dep. NTIS, PC A02/MF A01
1545-39	3:25629	Dep. NTIS, PC A05/MF A01
1743-46	3:25651	Dep. NTIS, PC A02/MF A01
1806-20	3:26141	Dep. NTIS, PC A10/MF A01
2035-10	3:25652	Dep. NTIS, PC A02/MF A01
2202-21	3:25653	Dep. NTIS, PC A04/MF A01
2218-15	3:25630	Dep. NTIS, PC A02/MF A01
2240-79	3:25631	Dep. NTIS, PC A02/MF A01
2244-15	3:25654	Dep. NTIS, PC A02/MF A01
2246-3(Rev.A)	3:26538	Dep. NTIS, PC A04/MF A01
2247-9R	3:25632	Dep. NTIS, PC A02/MF A01
2260-16	3:25655	Dep. NTIS, PC A08/MF A01
2286-20	3:25633	Dep. NTIS, PC A08/MF A01
2286-25	3:25615	Dep. NTIS, PC A04/MF A01
2307-25	3:25656	Dep. NTIS, PC A03/MF A01
2335-13	3:25657	Dep. NTIS, PC A09/MF A01
2335-16	3:25658	Dep. NTIS, PC A03/MF A01
2336-17	3:25634	Dep. NTIS, PC A03/MF A01
2340-4	3:25635	Dep. NTIS, PC A03/MF A01
2357-19	3:26142	Dep. NTIS, PC A03/MF A01
2371-20	3:26143	Dep. NTIS, PC A02/MF A01
2408-5	3:25681	Dep. NTIS, PC A04/MF A01
2433-17	3:25636	Dep. NTIS, PC A02/MF A01
2433-18	3:25637	Dep. NTIS, PC A02/MF A01
2435-16	3:25961	Dep. NTIS, PC A03/MF A01
2468-18	3:25638	Dep. NTIS, PC A02/MF A01
2473-15	3:26779	Dep. NTIS, PC A02/MF A01
2489-18	3:25712	Dep. NTIS, PC A02/MF A01
2516-4	3:25713	Dep. NTIS, PC A03/MF A01
2556-09	3:26152	Dep. NTIS, PC A04/MF A01
2564-9	3:25714	Dep. NTIS, PC A02/MF A01
2564-10	3:25715	Dep. NTIS, PC A02/MF A01
2565-10	3:25639	Dep. NTIS, PC A03/MF A01
2588-4	3:25659	Dep. NTIS, PC A02/MF A01
2893-6	3:25660	Dep. NTIS, PC A04/MF A01
FE/1216-		
2	3:25661	Dep. NTIS, PC A03/MF A01
FE/2343-		
1	3:26780	Dep. NTIS, PC A13/MF A01
FE/2664-		
3	3:26144	Dep. NTIS, PC A03/MF A01
FE-MIT-		
2295T26-3	3:25619	Dep. NTIS, PC A02/MF A01
GA-A-		
14034	3:26254	Dep. NTIS, MF A01
14592	3:26434	Dep. NTIS, PC A03/MF A01
14614(Vol.8)	3:27701	Dep. NTIS, PC A03/MF A01
14614(Vol.11)	3:27648	Dep. NTIS, PC A06/MF A01
GEFR-SP-		
049	3:26435	Dep. NTIS, PC A02/MF A01
050	3:26357	Dep. NTIS, PC A02/MF A01
GEMS-		
430	3:25956	*See* GESP-7134
GESP-		
7134	3:25956	Dep. NTIS, PC A20/MF A01
GFERC/RI-		
77/3	3:25617	Dep. NTIS, PC A02/MF A01
GJBX-		
22(78)	3:25907	*See* LA-7128-MS
GL-		
2684	3:26669	*See* AD-A-042273
2728	3:26732	*See* AD-A-046004
HCP/L50172-		
01	3:26531	Dep. NTIS, PC A13/MF A01
02	3:26532	Dep. NTIS, PC A02/MF A01
HCP/M1011-		
01	3:26580	Dep. NTIS, PC A25/MF A01
HCP/M1223-		
1	3:26509	Dep. NTIS, PC A05/MF A01
HCP/T2857-		
1	3:26522	Dep. NTIS, PC A10/MF A01
HEDL-		
6297	3:26282	AT
HEDL-SA-		
1258	3:26661	Dep. NTIS, PC A03/MF A01
HEDL-TI-		
75002-10	3:26436	AT
IAE-		
2520	3:27429	Dep. NTIS (US Sales Only), PC A02/MF A01
2552	3:27562	Dep. NTIS (US Sales Only), PC A02/MF A01
2650	3:27541	Dep. NTIS (US Sales Only), PC A03/MF A01
2651	3:27563	Dep. NTIS (US Sales Only), PC A02/MF A01
2655	3:27564	Dep. NTIS (US Sales Only), PC A02/MF A01
IAEA-SM-		
222/51	3:26991	Dep. NTIS, PC A02/MF A01
222/57	3:26817	Dep. NTIS, PC A02/MF A01
ID-		
75-45	3:25915	General Accounting Office, Washington, DC, $1.00
IIASA-CP-		
77-5	3:25721	Dep. NTIS (US Sales Only), PC A05/MF A01

Report No.	Abstract No.	Availability
IITRI-C-		
6370-1	3:26869	*See* AD-A-046052
INTEL-RT-		
8106-054	3:27403	*See* AD-A-042276
IPP-		
III/35	3:27491	Dep. NTIS (US Sales Only), PC A02/MF A01
IPPJ-		
252	3:27430	Dep. NTIS (US Sales Only), PC A02/MF A01
253	3:27565	Dep. NTIS (US Sales Only), PC A03/MF A01
255	3:27431	Dep. NTIS (US Sales Only), PC A02/MF A01
IPPJ-DT-		
49	3:27656	Dep. NTIS (US Sales Only), PC A02/MF A01
51	3:27657	Dep. NTIS (US Sales Only), PC A02/MF A01
IPPJ-T-		
25	3:27632	Dep. NTIS (US Sales Only), PC A02/MF A01
IS-M-		
125	3:26671	Dep. NTIS, PC A03/MF A01
IS-T-		
792	3:26837	Dep. NTIS, PC A04/MF A01
793	3:27367	Dep. NTIS, PC A07/MF A01
795	3:27363	Dep. NTIS, PC A04/MF A01
JAERI-M-		
6802	3:27633	Dep. NTIS (US Sales Only), PC A07/MF A01
6803	3:27649	Dep. NTIS (US Sales Only), PC A09/MF A01
6822	3:27702	Dep. NTIS (US Sales Only), PC A04/MF A01
6861	3:27467	Dep. NTIS (US Sales Only), PC A04/MF A01
6876	3:27432	Dep. NTIS (US Sales Only), PC A03/MF A01
6902	3:27566	Dep. NTIS (US Sales Only), PC A03/MF A01
6921	3:27634	Dep. NTIS (US Sales Only), PC A08/MF A01
6922	3:27703	Dep. NTIS (US Sales Only), PC A03/MF A01
6926	3:27597	Dep. NTIS (US Sales Only), PC A12/MF A01
6931	3:27468	Dep. NTIS (US Sales Only), PC A03/MF A01
6953	3:27635	Dep. NTIS (US Sales Only), PC A02/MF A01
6964	3:27433	Dep. NTIS (US Sales Only), PC A05/MF A01
6965	3:27504	Dep. NTIS (US Sales Only), PC A03/MF A01
6971	3:27613	Dep. NTIS (US Sales Only), PC A03/MF A01
6990	3:27434	Dep. NTIS (US Sales Only), PC A02/MF A01
7013	3:27614	Dep. NTIS (US Sales Only), PC A04/MF A01
7014	3:27615	Dep. NTIS (US Sales Only), PC A03/MF A01
7019	3:27505	Dep. NTIS (US Sales Only), PC A04/MF A01
JEN-		
379	3:27542	Dep. NTIS (US Sales Only), PC A08/MF A01
JPRS-		
69811	3:26533	NTIS
Juel-		
1399	3:27668	Dep. NTIS (US Sales Only), PC A04/MF A01
K/CSD/INF-		
77/17	3:26594	Dep. NTIS, PC A03/MF A01
KTA-		
2201.5	3:26473	Koeln, Germany, F.R.; Heymanns (1977).
3102.1	3:26259	Koeln, Germany, F.R.; Heymanns (Oct 1977).
LA-		
6807-PR	3:26504	Dep. NTIS, PC A05/MF A01
6824	3:27506	Dep. NTIS, PC A03/MF A01
6975-M	3:26917	Dep. NTIS, PC A03/MF A01
6987-MS	3:27015	Dep. NTIS, PC A02/MF A01
7009-MS	3:26818	Dep. NTIS, PC A02/MF A01
7022-MS	3:26819	Dep. NTIS, PC A02/MF A01
7058-PR	3:26997	Dep. NTIS, PC A03/MF A01
7064-MS	3:25985	Dep. NTIS, PC A04/MF A01
7076-PR	3:26961	Dep. NTIS, PC A03/MF A01
7083	3:26665	Dep. NTIS, PC A02/MF A01
7092-MS	3:27024	Dep. NTIS, PC A03/MF A01
7094-PR	3:25859	Dep. NTIS, PC A03/MF A01
7120-MS	3:26962	Dep. NTIS, PC A02/MF A01
7128-MS	3:25907	Dep. NTIS, PC A02/MF A01
LA-tr-		
77-66	3:26951	Dep. NTIS, PC A02/MF A01
78-1	3:27059	Dep. NTIS, PC A02/MF A01
78-2	3:26965	Dep. NTIS, MF A01
78-3	3:26964	Dep. NTIS, PC A03/MF A01
78-4	3:26966	Dep. NTIS, PC A03/MF A01
78-6	3:25704	Dep. NTIS, PC A02/MF A01
78-10	3:27645	Dep. NTIS, PC A02/MF A01
78-12	3:27651	Dep. NTIS, PC A02/MF A01
78-13	3:27650	Dep. NTIS, PC A02/MF A01
LA-UR-		
77-186	3:26050	Dep. NTIS, PC A09/MF A01
77-328	3:26737	Dep. NTIS, PC A02/MF A01
77-2511	3:27616	Dep. NTIS, PC A02/MF A01
77-2739	3:27717	Dep. NTIS, PC A03/MF A01
77-2790	3:26692	Dep. NTIS, PC A04/MF A01
77-2818	3:27016	Dep. NTIS, PC A02/MF A01
77-2835	3:27044	Dep. NTIS, PC A02/MF A01
77-2863	3:25903	Dep. NTIS, PC A02/MF A01
77-2876	3:27705	Dep. NTIS, PC A02/MF A01
77-2968	3:26888	Dep. NTIS, PC A03/MF A01
77-2985	3:25959	Dep. NTIS, PC A02/MF A01
77-3001	3:26824	Dep. NTIS, PC A02/MF A01
78-131	3:26051	Dep. NTIS, PC A04/MF A01
LBL-		
670	3:27332	Dep. NTIS, PC A03/MF A01
5275	3:26021	Dep. NTIS, PC A03/MF A01
5931	3:26114	Dep. NTIS, PC A04/MF A01
6351	3:26022	Dep. NTIS, PC A06/MF A01
6372	3:26878	Dep. NTIS, PC A02/MF A01
6597	3:27147	Dep. NTIS, PC A03/MF A01
6830	3:27658	Dep. NTIS, PC A02/MF A01
7004	3:25937	Dep. NTIS, PC A02/MF A01
7156	3:26803	Dep. NTIS, PC A02/MF A01
7211	3:26879	Dep. NTIS, PC A02/MF A01
7215	3:26830	Dep. NTIS, PC A02/MF A01
LT-		
1	3:26714	*See* AD-A-042229
LTR-		
10-2B	3:26228	Dep. NTIS, PC A06/MF A01
MDC-E-		
1669	3:26835	*See* AD-A-043777
MERADCOM-		
2211	3:26933	*See* AD-A-046203
MHSMP-		
77-50	3:26838	Dep. NTIS, PC A02/MF A01
MIT-		
78-TR3	3:25640	Dep. NTIS, PC A03/MF A01
2295-T18-3	3:26145	Dep. NTIS, PC A03/MF A01
2295-T18-4	3:26146	Dep. NTIS, PC A05/MF A01
MLM-		
2490	3:26666	Dep. NTIS, PC A02/MF A01
MR-		
7054	3:27042	*See* AD-A-046092
MRC-R-		
267	3:26833	*See* AD-A-043519
MSNW-		
76-130-1	3:27481	*See* AD-A-043486
MTI-		
78TR11	3:26585	Dep. NTIS, PC A03/MF A01
NADC-		
77027-30	3:26690	*See* AD-A-042618
NAMRL-		
1236	3:27001	*See* AD-A-043706
NASA-TM-		
73754	3:26126	*See* ERDA/NASA/1028-77/12
73789	3:26578	*See* CONS/1011-22
73799	3:26061	*See* ERDA/NASA/1060-77/1
NATO/CCMS-		
55	3:26572	*See* PB-270591-T/SL
NBS-SP-		
400-39	3:26825	*See* PB-269776
NBS-TN-		
955	3:27168	*See* PB-270968
NBSIR-		
77-862	3:25957	*See* PB-274058

Report No.	Abstract No.	Availability
NCSL-TM-		
212-77	3:25799	*See* AD-A-046123
NEDO-		
21480-02	3:26437	General Electricc Co., San Jose, CA
23697	3:26438	General Electric Co., San Jose, CA
24057	3:26207	General Electric Co., San Jose, CA
24076	3:26208	General Electric Co., San Jose, CA
NP-		
22640	3:25802	Geological Survey, Reston, VA
22642	3:26551	Sacramento, CA; Energy Resources Conservation and Development Commission (1977).
22643	3:26889	Nuclear Fuel Services, Inc., West Valley, NY
22644	3:26503	Lakewood, CO; Western Interstate Nuclear Board (1976). $7.00
22646	3:25764	Dep. NTIS (US Sales Only), PC A08/MF A01
22653	3:26520	Washington, DC; Georgetown University (1976). $3.00
22752	3:26053	Newark, DE; Univ. of Delaware (Mar 1976).
22758	3:26030	Palm Springs, CA; Canada-West (1977).
22812	3:26510	Washington, DC; Public Technology, Incorporated (1977).
22822	3:26502	Sacramento, CA; Energy Resouces Conservation and Development Commission (1976).
22951	3:25976	TIC
22952	3:26523	TIC
22953	3:25977	TIC
22964	3:25960	Institute of Gas Technology, Chicago, IL
22973	3:26571	NTIS
23020	3:25975	TIC
23021	3:25926	Environmental Protection Agency, Washington, DC
23033	3:26528	Dep. NTIS (US Sales Only), PC A03/MF A01
23043	3:26091	TIC
23044	3:26082	TIC
23046	3:26087	TIC
23047	3:26081	TIC
23050	3:26529	Dep. NTIS (US Sales Only), PC A04/MF A01
23054	3:26512	NTIS
23056	3:26527	Sacramento, CA; Energy Resources Conservation and Development Commission (1976).
23058	3:25824	GPO, $4.65
23061	3:26710	National Bureau of Standards, Cryogenic Data Center, Boulder, CO
23062	3:26530	Ames, IA; Iowa State University (1977).
23088	3:25682	West Virginia Univ., Morgantown
23089	3:25683	West Virginia Univ., Morgantown
NPS-		
61Bs77061	3:27356	*See* AD-A-042298
NRL-MR-		
3345-Rev	3:27036	*See* AD-A-042501
3521	3:27397	*See* AD-A-042211
3522	3:27536	*See* AD-A-043284
3556	3:27399	*See* AD-A-043502
3669	3:27669	Dep. NTIS, PC A02/MF A01
NRTC-		
77-28R	3:26836	*See* AD-A-046169
NSF/RANN/SE/AER-		
73-07957/PR/75/2	3:25994	*See* PB-273038
NSF/RANN/SE/GI-		
27976/72/4	3:25964	*See* PB-271142
NSWC/WOL/TR-		
77-47	3:26488	*See* AD-A-042182
NTIS/PS-		
77/0690	3:26197	National Technical Information Service, Springfield, VA
77/0700	3:25807	NTIS PCN01/MF N01
77/0701	3:25808	NTIS PCN01/MF N01
77/0706	3:25797	NTIS PCN01/MF N01
77/0709	3:26738	NTIS PCN01/MF N01
77/0710	3:26739	NTIS PCN01/MF N01
77/0716	3:26783	NTIS PCN01/MF N01
77/0750	3:25803	
77/0753	3:26988	
77/0790	3:26574	
77/0795	3:26153	
77/0796	3:26191	
77/0803	3:26598	
77/0804	3:26131	
77/0805	3:26132	
77/0806	3:26133	
77/0949	3:26931	NTIS PCN01/MF N01
77/0950	3:26918	NTIS PCN01/MF N01
77/0951	3:26919	NTIS PCN01/MF N01
77/0955	3:25991	NTIS PCN01/MF N01
77/0956	3:25992	NTIS PCN01/MF N01
77/0958	3:25993	NTIS PCN01/MF N01
77/0966	3:26656	NTIS PCN01/MF N01
77/0991	3:26147	NTIS PCN01/MF N01
77/0992	3:26148	NTIS PCN01/MF N01
77/1004	3:25804	NTIS PCN01/MF N01
77/1011	3:26990	NTIS PCN01/MF N01
Nuclearnotes-		
5	3:26886	*See* AD-A-046201
NUREG-		
0020(Vol.2)(No.1)	3:26209	NTIS, $10.00
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0120-4	3:26424	*See* SAND-77-1807
0333	3:26277	*See* ANL-77-20
NVO-		
171	3:26909	Dep. NTIS, PC A11/MF A01
NWC-TP-		
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ONRL-R-		
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ORAU-		
129	3:26893	Dep. NTIS, PC A02/MF A01
ORAU/IEA(M)-		
75-3	3:26868	Dep. NTIS, PC A03/MF A01
ORNL/CSD/TM-		
35	3:26283	Dep. NTIS, PC A03/MF A01
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ORNL/NUREG/TM-		
142	3:26439	Dep. NTIS, PC A04/MF A01
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ORNL/OEPA-		
3	3:26932	*See* ORNL/TM-6098
ORNL/TM-		
5895	3:26629	Dep. NTIS, PC A03/MF A01
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5999	3:26422	Dep. NTIS, PC A04/MF A01
6032	3:27636	Dep. NTIS, PC A07/MF A01
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6111	3:27435	Dep. NTIS, PC A03/MF A01
6130	3:26211	Dep. NTIS, PC A02/MF A01
6150	3:27637	Dep. NTIS, PC A03/MF A01
6200	3:26423	Dep. NTIS, PC A03/MF A01
6230	3:26190	Dep. NTIS, PC A04/MF A01
ORNL-tr-		
4479	3:26885	Dep. NTIS, PC A03/MF A01
ORO-		
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Report No.	Abstract No.	Availability
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271142	3:25964	
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271652	3:26200	NTIS PCA10/MF A01
272699	3:25695	NTIS PCA10/MF A01
273019	3:26193	NTIS PCA09/MF A01
273038	3:25994	NTIS PCA03/MF A01
273463	3:26920	NTIS PCA05/MF A01
273468	3:26935	NTIS PCA05/MF A01
273603	3:26936	NTIS PCA13/MF A01
273617	3:27027	NTIS PCA06/MF A01
273618	3:27028	NTIS PCA03/MF A01
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PNL-		
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R-ILC-		
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RE-P-		
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RLO/2225/T19-		
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RLO/2230/T4-		
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RLO/2230/T5-		
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RLO/2434-		
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RTI-		
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SAI-		
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SAN/1111-		
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SCI-		
6811	3:26198	*See* PB-271083
SGD-		
396-Pt-1	3:27027	*See* PB-273617
396-Pt-2	3:27028	*See* PB-273618
SLAC-		
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SLAC-PUB-		
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1624	3:27098	Dep. NTIS, PC A02/MF A01
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1733	3:27107	Dep. NTIS, PC A04/MF A01
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1745	3:27101	Dep. NTIS, PC A02/MF A01
1768	3:26820	Dep. NTIS, PC A02/MF A01
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1805	3:26796	Dep. NTIS, PC A02/MF A01
1806	3:27119	Dep. NTIS, PC A02/MF A01
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SR-		
21	3:27033	*See* AD-A-042185
SRI-MP-		
77-13	3:27033	*See* AD-A-042185
SRI-TR-		
9	3:27032	*See* AD-A-042183
SRL-		
6792-F	3:26715	*See* AD-A-042233
SRO-		
735-5	3:26968	Dep. NTIS, PC A02/MF A01
0888-2	3:26023	Dep. NTIS, PC A04/MF A01
SRO-NERP-		
1	3:26894	Dep. NTIS, PC A03/MF A01
SSS-R-		
76-2993	3:26863	*See* AD-A-043386
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SU-IPR-		
700	3:27025	*See* AD-A-043336
TI-		
03-72-159	3:26724	*See* AD-A-042490
03-75-26	3:26735	*See* AD-B-015785
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TI-ALEX-		
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TID-		
26712	3:26895	Dep. NTIS, PC A99/MF A01
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28013	3:26039	Dep. NTIS, PC A16/MF A01
28055	3:26984	Dep. NTIS, PC A02/MF A01
28062	3:27207	Dep. NTIS, PC A02/MF A01
28065	3:27120	Dep. NTIS, PC A02/MF A01
28078	3:26332	Dep. NTIS, PC A05/MF A01
28094	3:26284	AT
28130	3:26516	TIC
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TR-		
0077(2603)-3	3:26731	*See* AD-A-043812
TREE-NUREG-		
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TRITA-EPP-		
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TRITA-PFU-		
77-01	3:27598	Dep. NTIS (US Sales Only), PC A03/MF A01
77-02	3:27639	Dep. NTIS (US Sales Only), PC A02/MF A01
TSC-OST-		
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UCID-		
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17673	3:26998	Dep. NTIS, PC A02/MF A01
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17701	3:26884	Dep. NTIS, PC A02/MF A01
17703	3:27671	Dep. NTIS, PC A02/MF A01
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UCLA-		
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UCRL-		
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Report No.	Abstract No.	Availability
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80183	3:26827	Dep. NTIS, PC A02/MF A01
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11314	3:25823	Dep. NTIS, PC A02/MF A01
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USGS-OFR-		
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UWFDM-		
202	3:27618	Dep. NTIS, PC A06/MF A01
205	3:27619	Dep. NTIS, PC A03/MF A01
208	3:27620	Dep. NTIS, PC A02/MF A01
225	3:27640	Dep. NTIS, PC A02/MF A01
WCAP-		
9211	3:26445	Westinghouse Electric Corp., Pittsburgh, PA
WES-MP-M-		
77-12	3:26858	*See* AD-A-046146
WES-MP-S-		
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WES-TR-		
4-77-5	3:26481	*See* AD-A-042556
WES-TR-H-		
77-8	3:25979	*See* AD-A-043876
WFPS-TME-		
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055	3:27621	Dep. NTIS, PC A03/MF A01
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063	3:27643	Dep. NTIS, PC A02/MF A01
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Abbreviations Used in Availability Column

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Issue 4

October 1977

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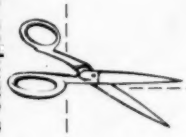

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